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Rio Blanco Oil Shale Project

DETAILED DEVELOPMENT PLAN
TRACT C-a

VOLUME 1

PROJECT BACKGROUND
and
EXECUTIVE SUMMARY

Gulf Oil Corporation . Standard Oil Company (Indiana)

March, 1976

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RIO BLANCO OIL SHALE PROJECT

DETAILED DEVELOPMENT PLAN
TRACT C-a

VOLUME 1

SECTION 1 PROJECT BACKGROUND

SECTION 2 EXECUTIVE SUMMARY

Submitted To Area Oil Shale Supervisor,
Geological Survey, U.S. Department of
the Interior, Pursuant To Lease No. C-20046

Gulf Oil Corporation - Standard Oil Company (Indiana)
March, 1976

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DDP ABSTRACT

In 1969, the U.S. Department of the Interior initiated planning for a prototype oil shale leasing program that eventually resulted in Gulf Oil Corporation and Standard Oil Company (Indiana) acquiring an oil shale lease for Tract C-a in the Piceance Creek basin of northwest Colorado. Gulf and Standard submitted the high bonus bid for Tract C-a ($210,305,600) at a lease sale in Denver on January 8, 1974. Rio Blanco Oil Shale Project (RBOSP) an organization directed and staffed by representatives of Gulf and Standard, was formed later that year for the purpose of developing Tract C-a.

In the past two years, RBOSP has conducted extensive geotechnical and environmental data collection programs designed to establish baseline conditions on and around Tract C-a and to provide input to engineering studies leading to the selection of mining and processing plans for Tract C-a development. This 4-volume detailed development plan (DDP) describes the baseline conditions and RBOSP's proposed construction and operation of a commercial-scale oil shale complex and support facilities on and around Tract C-a. Three major requirements must be met before development operations on Tract C-a can begin:

- The Area Oil Shale Supervisor, U.S. Geological Survey, must approve the development plan.
- Key Federal and State actions must be fulfilled and permits issued.
- The proposed development described in this plan must be commercially feasible at the time investments are committed.

PROJECT DESCRIPTION

RBOSP's ultimate goal with respect to Tract C-a development is to engage in commercial production of shale oil and associated by-products at as high a production rate as is feasible, consistent with environmental, technical and economic constraints that now prevail or may exist in the future.

Development will consist of open pit mining, off-tract surface retorting, and off-tract disposal of processed shale and overburden, and will be undertaken in two operating phases, each preceded by three-year construction periods. Phase I operation will consist of two stages, wherein first one, then two retort modules will be operated. This modular approach will provide RBOSP the opportunity to gain operating experience, improve process efficiency and confirm capital and operating costs before a full-scale oil shale complex is built. Phase II will be the commercial-scale complex. Table 1 is a summary of information pertinent to RBOSP's proposed development of Tract C-a. Figure 1 depicts the location of proposed RBOSP facilities.

Phase I - Stage 1 operations will begin during 1979 with a small open pit mine and a single TOSCO II retort capable of processing 10,700 tons of oil shale per day to produce approximately 4,500 barrels of pipelineable shale oil daily. Phase I - Stage 1 will include a thermal cracking plant for lowering the viscosity and pourpoint of raw shale oil so that it can be transported by pipeline. A sulfur recovery unit will also be included.

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TABLE 1

RIO BLANCO PROJECT SUMMARY

	PHASE I		PHASE II
	Stage I	Stage 2	
TIMING			
Construction	Apr. 1977-Aug. 1979	July 1980-Aug. 1982	Aug. 1982-Aug. 1985
Operation	Aug. 1979-Aug. 1982	Aug. 1982-Aug. 1985	Aug. 1985 and beyond
MINING			
Type	Open Pit	Open Pit	Open Pit
Ore Production	10,700 TPSD	21,400 TPSD	119,000 TPSD
Ore Haulage	Belt Conveyor	Belt Conveyor	Belt Conveyor
Overburden Haulage	Truck	Truck	Belt Conveyor
PROCESSING			
Retorting	TOSCO II	TOSCO II	Combination of TOSCO II & Gas Combustion/Paraho
Upgrading	Thermal Cracking	Thermal Cracking	Delayed Coking & Hydrotreating
Processed Shale Haulage	Truck	Truck	Belt Conveyor
PRODUCTS			
Pipelineable Shale Oil	4,500 BPSD	9,000 BPSD	-
Upgraded Shale Oil	-	-	55,800 BPSD
Sulfur	11 LTPSD	22 LTPSD	153 LTPSD
Ammonia (anhydrous)	-	-	232 TPSD
Coke	-	-	467 TPSD
Moisturized Processed Shale	11,000 TPSD	22,000 TPSD	118,500 TPSD
WATER DEMAND	1,390 AFY	2,370 AFY	10,000 AFY
POWER DEMAND	17.7 MW	28.8 MW	227 MW
PEAK EMPLOYMENT			
Construction	700	400	2,200
Operation	300	500	1,100

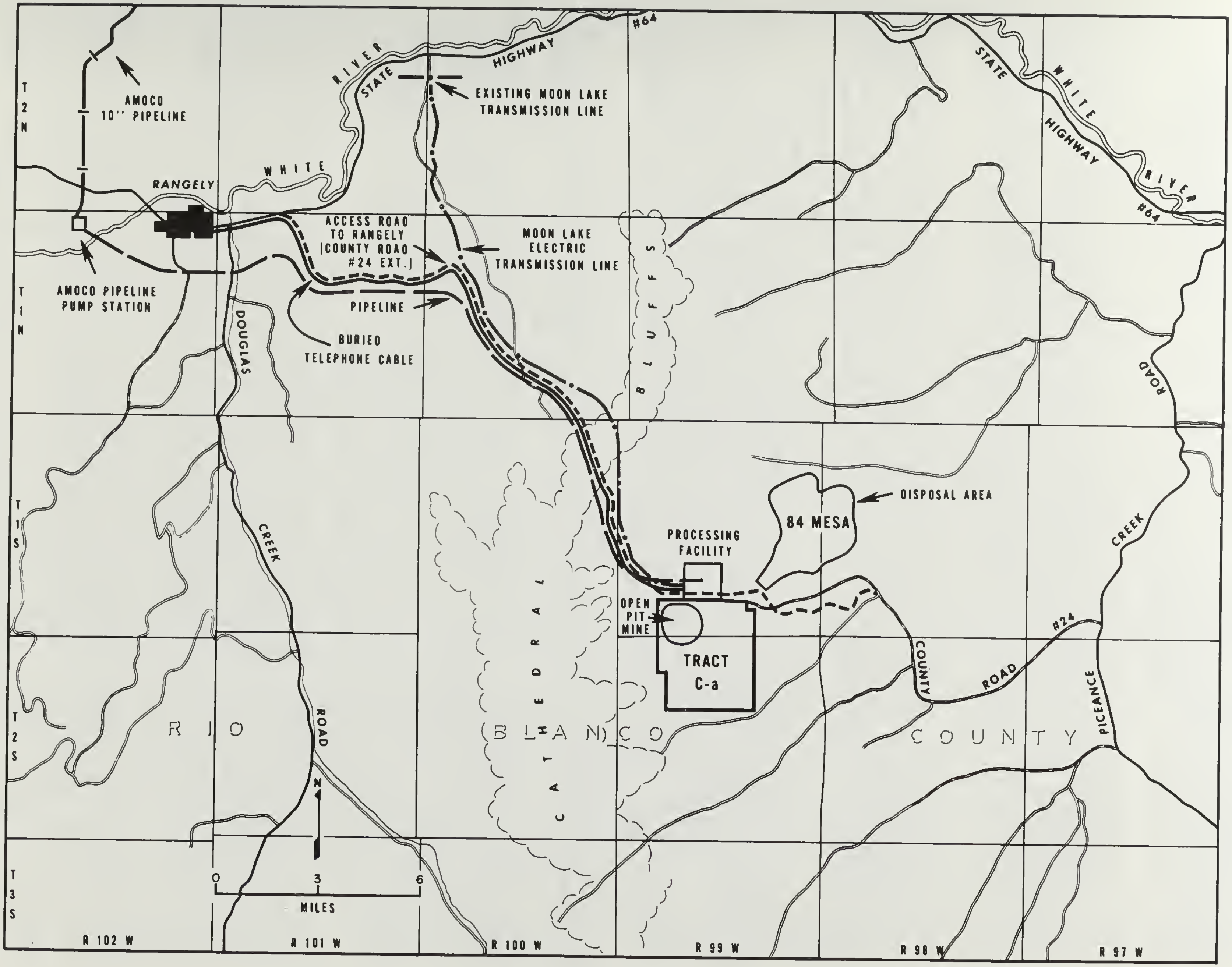

Figure 1

LOCATION OF PROPOSED RBOSP FACILITIES

Phase I - Stage 2 operations will begin three years later, during 1982, with the addition of a second TOSCO II retort, bringing total production to about 9,000 barrels per stream day (BPSD). Operation of the thermal cracking and sulfur recovery plants will continue. Construction of Phase II facilities will begin during Phase I - Stage 2 operations.

Phase II operations are scheduled to begin in mid-1985 using the best retorting technology available at that time, probably a combination of TOSCO II and gas combustion-type Paraho retorts, with a total processing capability of 119,000 tons per stream day (TPSD). Delayed coking and hydrotreating will be employed to produce upgraded shale oil at the rate of 55,800 BPSD. Phase II processing will also include hydrogen and oxygen production, high and low BTU gas production, sulfur and ammonia recovery, and coke production.

Open pit mining will begin in the northwest corner of Tract C-a and expand southeastwardly as ore production increases from 10,700 TPSD in Phase I - Stage 1 to 119,000 TPSD in Phase II. RBOSP selected open pit mining because it will allow maximum resource recovery from Tract C-a. Optimum development of the tract by open pit mining requires that the processing facility and processed shale and overburden disposal area be located off of Tract C-a as shown in Figure 1. Underground room-and-pillar mining would not require off-tract lands, but unless a feasible means of recovering oil shale from pillars is developed, nearly five times as much resource can be recovered from Tract C-a by open pit mining. From an environmental viewpoint, it is probable that one open pit operation will have less environmental impact in many ways than five room-and-pillar operations with their attendant disposal areas, roads, communications lines, power lines, and pipelines.

Selection of 84 Mesa as the location for processed shale and overburden disposal was based on an analysis incorporating environmental and operational comparisons of 16 potential disposal sites on and in the vicinity of Tract C-a. From an environmental standpoint, 84 Mesa ranked first among potential off-tract disposal sites and second overall. Operationally, 84 Mesa ranked first among all sites. Selection of the processing facility site was based on a similar analysis and on the additional considerations that it should be located: (1) in relatively close proximity to both the mine and the 84 Mesa disposal site; (2) on a topographic high rather than in a valley in order to enhance dispersion of stack emissions; and (3) on relatively level ground. A site at the north edge of Tract C-a was found to best satisfy these requirements.

Ore will be transported from the mine to the processing facility by belt conveyor during both Phases I and II. Processed shale and overburden will be hauled to disposal by trucks during Phase I and by belt conveyors during Phase II. After about 30 to 40 years of Phase II operations, it is expected that enough working space will have been created by mining to permit the backfilling of overburden and processed shale in the northwest portion of the open pit while mining continues in a southeasterly direction. As final slopes are established on the 84 Mesa disposal embankment, it will be progressively reclaimed. When backfilling the open pit begins, the disposal pile will have been contoured commensurate with existing topography and revegetated. Similarly, the backfilled portion of the open pit will be progressively reclaimed as operations proceed.

RBOSP's principal product (pipelineable shale oil in Phase I and upgraded shale oil in Phase II) will be transported by pipeline to Rangely, Colorado, thence through an existing AMOCO pipeline to other connecting carriers for ultimate delivery to refineries in the West or Midwest; a possible exception to this plan is during Phase I when shale oil may be trucked to an existing refinery near Fruita, Colorado. By-products (sulfur, ammonia and coke) will be trucked from Tract C-a to rail facilities near Rifle, Colorado.

RBOSP employment during Phase I will be about 700 for construction, 300 for Stage 1 operations and 500 for Stage 2 operations. Phase II construction employment will peak at about 2,200 while the Phase II operating force will total about 1,100 permanent employees. Overall RBOSP employment is expected to peak at 2,700 during the period from mid-1982 to mid-1985 when both Phase I - Stage 2 operations and Phase II construction are underway.

RBOSP water requirements will vary from about 1,400 acre-feet per year (AFY) during Phase I - Stage 1 to some 10,000 AFY during Phase II. Current data indicate that all water requirements through Phase II can be supplied from ground water sources on Tract C-a. Normal mine dewatering operations should provide most of the required amount, but some supplementary wells (all on Tract C-a) may be necessary.

Project power demand will be about 18 MW during Phase I - Stage 1 operations and will increase to some 227 MW during Phase II. Moon Lake Electric Association will supply electricity to Tract C-a via a 230-KV transmission line from an existing line near the White River some 20 miles north of the tract. Mountain Bell Telephone Company will provide communications via a buried telephone cable from Rangely. Vehicular access to Tract C-a will be via Rio Blanco County Road 24 (Ryan Gulch Road) from the east and via an extension of this road from the tract to Rangely on the west. The power tranmission line, shale oil pipeline, telephone cable, and access road will be located, wherever possible in a common corridor between Rangely and Tract C-a.

If Phase II operations prove to be environmentally, technically and economically successful, RBOSP may elect to increase production above 55,800 BPSD. Current RBOSP estimates indicate that Tract C-a reserves are adequate to support a shale oil production of up to 300,000 BPSD. Such expansion could be achieved, for example, in two-125,000 BPSD increments.

Anticipating this possibility, RBOSP is already taking initial planning steps in areas where long lead times are necessary, the most important of which is securing rights to adequate surface water supplies. In addition to more water, increased production would also require a larger processing facility -- the Phase I and II processing facilities are located at a site where there is enough room for expansion. The need for additional off-tract lands for processed shale and overburden disposal is not anticipated since the void created during the first 30 to 40 years of Phase II mining should be sufficient to allow subsequent mining to stay ahead of backfilling operations, regardless of production rates.

Expansion beyond Phase II is treated only conceptually in this development plan because detailed planning for such expansion (excepting the acquisition of water rights) cannot begin until Phase II is underway. Ultimately, however, maximum recovery of resource from Tract C-a (and thus, maximum resource conservation) can only be realized by completely mining the tract. Furthermore, leaving exposed mining faces at the south and east boundaries of Tract

C-a will permit future developers on adjacent leases to continue open pit mining where RBOSP operations end.

BASELINE ENVIRONMENTAL AND GEOTECHNICAL CONDITIONS

As noted earlier, RBOSP has initiated extensive geotechnical and environmental baseline data collection programs on and around Tract C-a. These programs are designed to obtain data needed for engineering studies and development plans as well as fulfilling specific lease requirements.

Geotechnical data collection is subdivided into geologic and hydrologic programs. The geologic program is designed to provide detailed topographic, structural, stratigraphic, and resource data. The hydrologic program will provide data for determining baseline hydrologic conditions, aquifer characteristics, and for predicting the quantity of water expected to be produced during open pit mining.

The baseline environmental program designed by RBOSP complies with lease stipulations and, in addition, reflects the following goals: (1) to identify any potential data gaps that might exist in the lease stipulations and develop programs to correct such oversights; and (2) to evaluate lease stipulations and, if appropriate, suggest amendments that would best serve the environmental spirit enunciated in the lease.

The baseline environmental program was approved by the Area Oil Shale Supervisor following review and recommendations by the Oil Shale Environmental Advisory Panel. The program includes data collection in the following disciplines: air quality, meteorology, terrestrial and aquatic ecology, soil characterization, archaeology, and paleontology. Data from all elements are combined to describe overall ecological interactions. Incorporated in the design of these programs is a flexibility allowing response to changes indicated by the constantly expanding data base, without altering original objectives. For example, the study area in some programs was expanded from the original design to ensure coverage of potential disposal and processing facility sites. In addition to characterizing the physical and biological components of the Tract C-a study area, both qualitatively and quantitatively, the baseline environmental program will yield data for designing a monitoring program to measure changes caused by development.

ENVIRONMENTAL PROTECTION

RBOSP has developed specific environmental protection procedures to ensure compliance with lease provisions and environmental stipulations, and with all applicable Federal, State and local environmental protection and pollution control regulations. These procedures, or mitigation plans, are designed specifically for RBOSP's intended development of Tract C-a and will be modified, if necessary, as changing conditions are noted. The protection procedures described in this development plan cover the following topics:

Health and Safety
Air Quality Control
Water Quality Control
Solid Waste Control
Noise Control
Aesthetics
Abandonment
Fish and Wildlife Management
Land Rehabilitation
Oil and Hazardous Materials Control
Fire Prevention and Control
Protection of Objects of Historic and Scientific Interest

RBOSP has conducted an environmental assessment of proposed Tract C-a development. This assessment was based on the fact that the protection plans listed above will be implemented and that they will be modified as conditions dictate. The results of this assessment are that Tract C-a development alone will have slight, if any, impact on the functioning of the overall Piceance Creek basin ecosystem.

Various environmental monitoring programs will be conducted to provide a record of changes from conditions existing prior to development as established by the baseline data collection program, and to serve as a continuous check on compliance with lease provisions and applicable Federal, State and local environmental protection and pollution control regulations. Programs have been designed to monitor air quality, meteorology, hydrology, terrestrial and aquatic ecology, and revegetated areas. Analysis of data collected during the baseline program provides the basis for selecting those parameters that will most effectively indicate detrimental effects and, thus, the necessity for taking corrective action such as altering one of the environmental protection plans.

The monitoring programs will be initiated six months before development begins on Tract C-a. Monitoring will continue until the Area Oil Shale Supervisor determines to his satisfaction that environmental conditions consistent with Federal and State statutes and regulations have been established.

SOCIO-ECONOMIC PLANNING

Gulf and Standard recognized the potential social and economic impacts of oil shale development when the Tract C-a lease was acquired in January 1974. The two companies pledged then to cooperate with, support and participate in regional planning with the communities affected and with local, county, state and Federal governmental agencies.

A socio-economic plan is not legally required by the Tract C-a lease, but RBOSP officials and the Area Oil Shale Supervisor feel that such a plan is desirable. The overall objectives of RBOSP's socio-economic planning activities are to reduce negative impacts and to avoid the mistakes and resulting problems encountered in other areas experiencing significant population increases caused by new industry. RBOSP's plan to achieve these goals is described in a socio-economic report submitted separately from the detailed development plan.

STATE AND FEDERAL ACTIONS NEEDED BEFORE RBOSP CAN PROCEED

A variety of state and Federal actions are necessary before RBOSP can implement development of Tract C-a as described in this document. Specific actions needed are as follow:

- Area Oil Shale Supervisor approval of the detailed development plan
- Bureau of Land Management issuance of right-of-way permits for
    - pipeline to Rangely
    - road to Rangely
    - power transmission line
    - telephone cable
- BLM approval of use of 84 Mesa for disposal area
- BLM approval of use of offsite lands for processing facility
- Townsite lands are made available to Rangely by the BLM
- State appropriation for and construction of access roads
- State legislation to enable a town to receive and administer townsite lands
- An acceptable land trade with State Division of Wildlife for surface lands on and around Tract C-a
- State reclassification of air quality designation for area on and around Tract C-a
- Issuance of all required State and Federal permits

DDP ORGANIZATION AND USE

RBOSP's DDP consists of 11 sections comprising four volumes, as depicted in the chart on page 9. Volume 1 includes sections entitled "Project Background" and "Executive Summary." If one is interested in an overview of the development plan, Volume 1 is recommended.

Volume 2 is the largest of the four volumes. It describes baseline geological, hydrological and environmental conditions on and around Tract C-a. Volume 3 describes engineering plans for developing Tract C-a and includes sections on mining, retort feed preparation, processing, processed shale and overburden disposal and support facilities. Volume 4 describes RBOSP's environmental protection plans and also includes sections concerning environmental assessment and monitoring. The Confidential Volume, which is not publicly available, contains proprietary information concerning oil shale properties and ore reserve and cost estimates.

Except for the DDP abstract, a 3-number page numbering system is used throughout the development plan. Any given page number is unique in that it is not repeated elsewhere in the DDP. Page numbers are keyed to chapters within sections; page 3-4-45, for example refers to the 45th page of Chapter 4, (Hydrology of Section 3 (Baseline Conditions).

RIO BLANCO OIL SHALE PROJECT
DETAILED DEVELOPMENT PLAN ORGANIZATION

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PROJECT BACKGROUND

CHAPTER 1

INTRODUCTION

The Green River formation oil shales occurring beneath a 25,000-square mile area in northwestern Colorado, eastern Utah and southwestern Wyoming represent the world's largest known concentration of hydrocarbon resources. The amount of oil ultimately recovered from this vast storehouse of energy will depend on technical, economic and environmental constraints, but could vary from 80 billion to more than one trillion barrels.

Attempts to produce shale oil on a commercial basis in the United States date back to the 19th century, but economics (and to a lesser extent, technology) always became the deciding factor in preventing development. With dwindling world reserves of conventional sources of petroleum and attendant higher prices, the need for oil shale development now appears to be more desirable than in the past.

This detailed development plan (DDP) describes a program by which Gulf Oil Corporation and Standard Oil Company (Indiana) intend to engage in commercial production of shale oil from Federal Tract C-a in the Piceance Creek basin of northwest Colorado. It is submitted in accordance with provisions of an oil shale lease (Serial No. C-20046) issued to Gulf and Standard in February 1974 by the Bureau of Land Management, U. S. Department of the Interior (DOI).

CHAPTER 2
PROTOTYPE OIL SHALE LEASING PROGRAM

2.1 HISTORICAL

The Department of the Interior's Prototype Oil Shale Leasing Program dates back to planning activities initiated in October 1969 after a previous leasing attempt was unsuccessful in December 1968.

An interagency oil shale task force was formally established in December 1969 and its work was seemingly culminated in May 1970 with submission of a proposed program to then Interior Secretary Walter J. Hickel. But Secretary Hickel rejected the proposal and directed the task force to further evaluate the environmental effects of the program before it was implemented.

This led to the creation of joint state-Federal-industry committees (appointed by the Governors of Colorado, Utah and Wyoming) to study the environmental aspects of oil shale development in each of the three states. Their studies were completed and reports submitted to the Interior Secretary in February 1971. The information in these reports was used to prepare a draft environmental impact statement and it, together with a program statement on the proposed prototype program, was released to the public on June 29, 1971.

Release of these documents, which set in motion the events that led to the 1974 oil shale lease sales, was preceded by President Nixon's "Clean Energy" message to Congress on June 4, 1971, wherein he said,

> "I believe the time has come to begin the orderly formulation of a shale oil policy -- not by any head-long rush toward development but rather by a well-considered program in which both environmental protection and the recovery of a fair return to the Government are cardinal principles under which any leasing takes place."

The first step in the leasing program announced on June 29, 1971, was informational corehole drilling by firms interested in acquiring an oil shale lease;

industry responded by drilling 16 holes during the fall and winter of 1971-72. At Interior's invitation, industry then nominated 20 tracts in Colorado, Utah and Wyoming as potential lease areas in January 1972. Interior selected six tracts, two in each state, as having the best potential for satisfying the goals and objectives of the prototype program. Additional informational corehole drilling was conducted during 1972 and 1973.

A revised and greatly expanded draft EIS on the program was released in September 1972. A series of public hearings was held a month later in the states in which the selected lease tracts were located. This was followed by another 11 months of work by Interior's oil shale task force before the final environmental impact statement was released on August 30, 1973. Three months later (on November 28, 1973) Interior Secretary Rogers C. B. Morton announced his decision to proceed with the program and that the first lease sale (of Colorado Tract C-a) would be held in January 1974. Gulf and Standard submitted the high bonus bid for Tract C-a of $210,305,600.00 at the sale in Denver on January 8, 1974. The lease was formally signed by the Colorado State Director of the Bureau of Land Management on February 5 and became effective on March 1, 1974.

2.2 OBJECTIVES

The objectives of the Department of the Interior in its prototype leasing program, as set forth in the June 1971 program statement, are to:

- Provide a new source of energy to the Nation by stimulating the development of commercial oil shale technology by private industry;
- Ensure the environmental integrity of the affected areas and at the same time to develop a full range of environmental safeguards and restoration techniques that will be incorporated into the planning of a mature oil shale industry, should one develop;
- Permit an equitable return to all parties in the development of this public resource; and

- Develop management expertise in the leasing and supervision of oil shale development in order to provide the basis for future administrative procedures.

Gulf and Standard concur with and support these objectives and, as oil shale lessees, have the following overall goal:

- To engage in commercial production of shale oil and associated products or by-products from Tract C-a at as high a production rate as is feasible, consistent with environmental, technical and economic constraints that now prevail or may exist in the future.

In accordance with rules established by the Department of the Interior, a preliminary plan for development of Tract C-a was submitted to DOI by Gulf and Standard in early February 1974, within 48 hours after being notified that they had been awarded the lease for Tract C-a. The preliminary development plan expressed, in more detail, the companies' planning objectives with respect to Tract C-a development:

- To comply with lease terms requiring submittal of data for review by appropriate government agencies and also to keep the public informed of plans and progress through a series of regular progress reports;
- To conceive, coordinate and execute engineering studies of mining and processing methods and equipment in a manner designed to enhance project economics and achieve the earliest feasible start-up date;
- To incorporate environmental considerations into project engineering studies and decisions throughout the life of the project;
- To submit for approval of the Area Oil Shale Supervisor, at the earliest possible date, an acceptable plan describing the exploratory work proposed to be undertaken on the tract;
- To see that the general requirements set forth in the lease's environmental stipulations are transformed into specific plans that will address all aspects of the lease;

- To conduct an integrated environmental baseline study of the total ecology of Tract C-a to provide an understanding of the basic ecological interrelationships important for successful environmental protection and to allow identification of those ecological parameters that are important to be monitored as indicators of environmental quality;
- To gather socio-economic data directly related to project development as an aid to projections and assessments of probable impacts resulting from a prototype oil shale industry in the area and to estimate the number of construction and operating employees required; and
- To cooperate with, support and participate in regional planning by the communities affected and with local, county, state and Federal government agencies.

This detailed development plan responds to the first six items listed above while RBOSP's "Social and Economic Impact Statement for Tract C-a," a document submitted separately from the DDP, responds to the last two items.

CHAPTER 3
LEASE PROVISIONS

3.1 TRACT C-a LOCATION

Tract C-a comprises about 5,100 acres in Rio Blanco County, Colorado, some 20 miles southeast of Rangely. The specific lands covered by the Tract C-a lease are legally described as follows:

T1S, R99W, 6th P.M.
Sec. 32: E1/2, E1/2W1/2
Sec. 33: All
Sec. 34: W1/2, SE1/4, W1/2NE1/4, SE1/4NE1/4

T2S, R99W, 6th P.M.
Sec. 3: All
Sec. 4: All
Sec. 5: E1/2, E1/2W1/2 (incl. Lots 1, 2, and 3)
Sec. 8: E1/2
Sec. 9: All
Sec. 10: All

3.2 TERM

The oil shale lease issued to Gulf and Standard on February 5, 1974, is for a period of 20 lease years from the effective date (March 1, 1974) and so long thereafter as there is production from the leased deposits in commercial quantities, subject to readjustment of terms and conditions at 20-year intervals following the effective date.

3.3 BONUS PAYMENTS

Pursuant to procedures established by the Department of the Interior for the Prototype Leasing Program, Gulf and Standard submitted a check for $42,061,120.00 on the day of the Tract C-a bid opening to cover one-fifth of the bonus amount bid. Subsequent bonus installments in like amounts were submitted to the Bureau of Land Management on March 1, 1975, and March 1, 1976. Section 5 of the Tract C-a oil shale lease provides that Gulf and Standard can credit development expenditures made prior to the third lease anniversary date (March 1, 1977) against the fourth bonus installment due on March 1, 1977. Similarly, development expenditures made before the fourth anniversary date (March 1, 1978), can be credited against the fifth bonus installment due on March 1, 1978; also creditable to the fifth bonus payment are any expenditures made before but not credited against the fourth bonus payment. To qualify as credits, expenditures must, according to the lease, be directly attributable to operations on the leased lands for development of the leased deposits; expenditures made for preparation of the detailed development plan do not qualify. In June 1975, the Department of the Interior published guidelines which further clarify the types of expenditures that may be credited against bonus payments.

Section 5 also provides that Gulf and Standard may relinquish the lease at any time prior to the third anniversary date (March 1, 1977) and be relieved of any obligation to pay the fourth and fifth bonus installments mentioned above. The total bonus payment, in that event, would be $126,183,420.00. The Mineral Leasing Act of 1920 provides that the Tract C-a lease bonus, rental and royalty payments be distributed in the following manner:

Federal Reclamation Fund	52.5%
U. S. Treasury	10.0%
State of Colorado	37.5%

The State of Colorado will thus receive a minimum of $47,318,782.50 by virtue of RBOSP bonus payments for Tract C-a.

3.4 RENTALS

Annual rental for the lands in Tract C-a is 50 cents per acre, or fraction thereof, except that rental for any lease year can be credited against any royalty payments due and payable in that lease year; in those years when no royalties are due, the rental for the tract is $2,545.00.

3.5 ROYALTIES

The lease contains provisions for computing royalties due on production from Tract C-a. The royalty rate is adjusted each year by the change (either up or down) in the combined average value per barrel of all crude oil and crude shale oil produced in the states of Colorado, Wyoming and Utah. The payment of a minimum royalty is required in the sixth and each succeeding lease year even if no actual production has been achieved by that time.

Certain lease provisions allow for reducing royalties due on actual production during lease years 6 to 10. In addition, the lease provides that annual rentals may be credited against royalty due in any lease year and that the Interior Secretary may excuse Gulf and Standard from compliance with minimum royalty requirements during any year in which the lessees are prevented from implementing the DDP by circumstances beyond their control.

3.6 ENVIRONMENTAL PROTECTION

The lease contains specific requirements for environmental protection and for developing environmental information. Section 11 reads:

> "The lessee shall conduct all operations under this lease in compliance with all applicable Federal, State and local water pollution control, water quality, air pollution control, air quality, noise control, and land reclamation statutes, regulations, and standards.
>
> "The lessee shall avoid, or, where avoidance is impracticable, minimize and, where practicable, repair damage to the environment, including the land, the water and air."

Also incorporated in the lease is a lengthy list of environmental stipulations dealing with the following topics:

- Access and service plans
- Fire prevention and control
- Fish and wildlife

- Health and safety
- Historic and scientific values
- Oil and hazardous materials
- Air pollution
- Water pollution
- Noise control
- Rehabilitation
- Scenic values
- Vegetation
- Waste disposal

The environmental stipulations require the collection of baseline environmental data for two consecutive full years, one full year of which was required before submission of the detailed development plan. The lease further requires that, after collecting baseline data for two years, Gulf and Standard must conduct an environmental monitoring program beginning six months prior to commencement of development operations; the monitoring program must continue until the Area Oil Shale Supervisor is satisfied that environmental conditions consistent with applicable Federal and State statutes and regulations are established.

CHAPTER 4
DETAILED DEVELOPMENT PLAN

4.1 REQUIREMENT FOR DDP

The requirement for filing a detailed development plan (DDP) with the Area Oil Shale Supervisor (AOSS) on or before the third anniversary date of the lease may be found in Section 10 of the oil shale lease. The DDP, according to the lease, is to include the following:

- A schedule of the planning, exploratory, development, production, processing and reclamation operations and all other activities to be conducted under the lease; and
- A detailed description pursuant to 30 CFR Part 231 and 43 CFR Part 23 of the procedures to be followed to assure that the DDP and all operations thereunder will meet and conform to the environmental criteria and controls incorporated in the lease.

Furthermore, the DDP is to reflect a program ensuring due diligence for the orderly development of the leased deposits.

Section 1c of the environmental stipulations incorporated in the lease indicates that an environmental monitoring program is to be an integral part of the DDP. Also, at the time the DDP is submitted, Gulf and Standard are to provide to the Area Oil Shale Supervisor a complete compilation of the baseline environmental data collected to date pursuant to the lease.

4.2 PURPOSE OF THE DDP

The basic purpose of this DDP is to describe the program planning activities being conducted and to disseminate information concerning the manner in which Gulf and Standard intend to develop Tract C-a and surrounding areas.

CHAPTER 5
LEASE HISTORY

5.1 CREATION OF RIO BLANCO OIL SHALE PROJECT

The first several months after award of the lease were devoted to various organizational tasks that culminated on July 10, 1974 when Gulf and Standard announced creation of Rio Blanco Oil Shale Project (RBOSP), an organization directed and staffed by a combination of representatives from each parent company. RBOSP's sole purpose is the development of Tract C-a.

5.2 EXPLORATORY PLAN

In May 1974, prior to official formation of RBOSP, an exploratory plan as required by Section 10d of the lease was submitted to and approved by the Area Oil Shale Supervisor of the U.S. Geological Survey. The document detailed plans by Gulf and Standard for obtaining environmental baseline data, establishing monitoring programs and acquiring resource data needed for studies leading to the selection of the mining, processing, and environmental protection systems and procedures that are the subject of this detailed development plan.

5.3 GEOTECHNICAL DATA COLLECTION

Geotechnical data gathering, including geologic and hydrologic resource evaluation through core hole drilling and geophysical logging began in July 1974. The geologic program conducted by RBOSP was designed to provide detailed structural, stratigraphic and resource data and was subdivided into nine tasks to accomplish these goals.

The hydrologic program was conducted by RBOSP to provide the data for determining the following: (1) hydrologic environment baseline, (2) aquifer characteristics and quality, and (3) quantity of water expected to be produced from various mining plans. The hydrologic program was subdivided into eight tasks.

5.4 BASELINE ENVIRONMENTAL DATA COLLECTION

An extensive environmental baseline data gathering program is being conducted by RBOSP to meet the following two objectives: (1) compliance with lease stipulations and (2) formulation of a scientifically sound baseline program. The following goals were specified by RBOSP's scientific experts:

- Identify any potential data gaps which might exist in lease stipulations, and develop programs to include these.
- Evaluate lease stipulations which, if amended, might best serve the spirit enunciated in the lease.
- Assign technical priorities and allocation of money for each component of the baseline data accumulation program.

After thorough evaluation and study, a final scope of work was submitted to and approved by the Area Oil Shale Supervisor following review and recommendation by the Oil Shale Environmental Advisory Panel. Programs were designated to determine meteorology and air quality, to study both terrestrial and aquatic ecology, to describe plant and animal relationships, to characterize soils, and to identify areas of paleontological and archaeological interest. The environmental program baseline data was used to determine ecological interactions.

Collection of baseline environmental data began in October 1974, but because individual tasks started at various times, one full year of collection in some categories was not completed until early February 1976. RBOSP retained Limnetics, Inc. to administer and monitor the various environmental baseline data gathering programs.

5.5 QUARTERLY PROGRESS REPORTS

Baseline geotechnical and environmental data have been regularly described in quarterly progress reports prepared by Rio Blanco Oil Shale Project. The first such report was submitted to the Area Oil Shale Supervisor in October 1974; it covered the period from lease issuance through September 30, 1974. Subsequent quarterly progress reports were submitted to the AOSS in March, July and November 1975, and March 1976.

5.6 MINING AND PROCESSING STUDIES

Rio Blanco Oil Shale Project retained Morrison-Knudsen Company, Inc. and Foster Wheeler Energy Corp. in December 1974 to perform conceptual engineering studies to encompass all phases of developing a major oil shale mine and processing plant plus the necessary support facilities for production of crude shale oil in commercial quantities.

The primary objectives of the studies, completed in January 1976, were (1) to provide information for inclusion in the detailed development plan, and (2) to examine the technical and economic viability of the Tract C-a project. M-K subdivided their task into five major work areas:

- Mining
- Crushing and materials handling
- Support facilities
- Environmental control plans

Foster Wheeler studied the processing (retorting and upgrading) facilities.

SECTION 2

EXECUTIVE SUMMARY

CHAPTER 1

PROJECT OVERVIEW

1.1 DEVELOPMENT OBJECTIVE

The ultimate goal of the Rio Blanco Oil Shale Project is to engage in commercial production of shale oil and associated by-products from Tract C-a at as high a production rate as is feasible, consistent with environmental, technical and economic constraints that now prevail or may exist in the future. The retorting technology to be used in developing Tract C-a, however, has never been successfully demonstrated on a commercial scale. Thus, RBOSP feels it is prudent to proceed initially on a small scale to prove technical, environmental and economic feasibility. A modular approach will therefore be employed, rather than immediately constructing a full-scale commercial complex.

The first six years of operation, beginning in mid-1979, will be planned at a purposely modest level in order to gain operating experience, improve process efficiency, confirm capital and operating cost estimates, and to verify the environmental integrity of mining, processing and disposal operations. These early years of development will comprise Phase I which will consist of two operating stages wherein one TOSCO II retort module will be operated for the first three years, and two during the following three years.

Phase II will be the planned operation of a full-scale commercial complex beginning in mid-1985. Phase II production will be 55,800 BPSD. Since Tract C-a oil shale reserves are adequate to support a much higher production rate--as much as 300,000 BPSD--RBOSP will continually evaluate the project's success and may elect to increase production above 55,800 BPSD at any time following 1985. In that event, RBOSP would file an amendment to this development plan with the Area Oil Shale Supervisor, as required by the lease.

This detailed development plan describes the six years of Phase I operation in detail; Phase II design and operation are described in somewhat less detail, but still with enough specific information to permit a meaningful assessment of the environmental effects of operations at the Phase II production level for 30 years.

Expanded operations beyond Phase II production of 55,800 BPSD are treated only conceptually, because much will be learned during Phase II that will affect the design of an expanded operation if one is undertaken. In other words, experience gained during Phase II operations can be expected to improve mining techniques, process efficiencies, environmental protection measures and other operating procedures in a manner that could have a profound effect on the design and operation of an expanded project. The nature or magnitude of such improvements cannot be predicted at this time. As indicated earlier, a DDP amendment will be filed with the AOSS if RBOSP elects to expand production beyond 55,800 BPSD.

The development plan, environmental protection plans and environmental monitoring programs described in this DDP are based on the best technology available. Specific details concerning engineering or environmental design of these plans and programs will change because technology in these areas is continually changing and improving. RBOSP will be responsive to changes in information and technology by retaining a flexibility permitting changes in design and operations. As new or improved technology becomes available, it will be incorporated in the design and operation of the project wherever warranted.

Environmental portions of this DDP are based on one year of baseline data collection and any applicable information previously reported in the literature. There is no way to determine whether these data are representative of long-term averages or trends. The second year of baseline data collection may reveal information that changes conclusions presented in the DDP. Such changes could, in turn, lead to alterations in project design, operation and/or environmental monitoring programs.

A statement frequently heard with respect to ecosystem dynamics is that "everything affects everything else." This is also true for a project of the nature and magnitude of that proposed by RBOSP in this DDP. Mine design, for example, is dependent on Tract C-a geology and hydrology -- any identifiable changes in baseline geology and hydrology, as described herein, could alter mine design. Similarly, geologic and hydrologic conditions encountered during later mining can change mine operations. RBOSP's objective is to establish a system that is responsive to changes of this nature, whether they be economic, technical or environmental.

RBOSP's plan is to construct and operate an environmentally-sound oil shale complex. Protection of the three principal components of man's environment will be accomplished by RBOSP in the following manner:

- Water quality control will be achieved through the implementation of a zero discharge concept.
- Air quality control will be achieved by designing equipment and facilities to minimize emissions and by using the best technology available to control any emissions that cannot otherwise be reduced by design changes.
- RBOSP's objective is to avoid or minimize land disturbance wherever practicable. Rehabilitation of disturbed land will be undertaken through a program incorporating site preparation, erosion control and revegetation.

RBOSP's environmental protection programs will be modified, as necessary, in response to data collected in various monitoring programs.

1.2 OVERALL PROJECT DESCRIPTION AND DEVELOPMENT SCHEDULE

The proposed development plan presented in this document consists of open pit mining, off-tract surface retorting, and off-tract disposal of processed shale and overburden. Tract C-a development will be undertaken in two operating phases, each preceded by three-year construction periods. Phase I operations will consist of two stages wherein first one, then two retort modules will be operated. Phase II will be the commercial-scale complex. Table 2-1-1 is a summary of information pertinent to RBOSP's proposed development of Tract C-a. Figure 2-1-1 shows RBOSP's proposed construction and operating schedule.

Phase I - Stage 1 operations will begin during 1979 with a small open pit mine and a single TOSCO II retort capable of processing 10,700 tons of oil shale per day to produce approximately 4,500 barrels of pipelineable shale oil daily. Phase I - Stage 1 will include a thermal cracking plant for lowering the viscosity and pourpoint of raw shale oil so that it can be transported by pipeline. A sulfur recovery unit will also be included.

Phase I - Stage 2 operations will begin three years later, during 1982, with the addition of a second TOSCO II retort, bringing total production to about 9,000 barrels per stream day (BPSD). Operation of the thermal cracking and sulfur recovery plants will continue. Construction of Phase II facilities will begin during Phase I - Stage 2 operations.

Phase II operations are scheduled to begin in mid-1985 using the best retorting technology available at that time, probably a combination of TOSCO II and gas combustion-type Paraho retorts, with a total processing capability of 119,000 tons per stream day (TPSD). Delayed coking and hydrotreating will be employed to produce upgraded shale oil at the rate of 55,800 BPSD. Phase II processing will also include hydrogen and oxygen production; high and low BTU gas production, sulfur and ammonia recovery, and coke production.

Figures 2-1-2 and 2-1-3 depict the location of proposed RBOSP facilities. Open pit mining will begin in the northwest corner of Tract C-a and expand southeastwardly as ore production increases from 10,700 TPSD in Phase I - Stage 1 to 119,000 TPSD in Phase II. RBOSP selected open pit mining because it will allow maximum resource recovery from Tract C-a. Optimum development of the tract by open pit mining requires that the processing facility and processed shale and overburden disposal area be located off Tract C-a. Underground room-and-pillar mining would not require off-tract lands, but unless a feasible means of recovering oil shale from pillars is developed, nearly five times as much

TABLE 2-1-1

RIO BLANCO OIL SHALE PROJECT SUMMARY

	PHASE I		
	Stage I	Stage 2	PHASE II
MINING			
Type	Open Pit	Open Pit	Open Pit
Production	10,700 TPSD	21,400 TPSD	119,000 TPSD
Ore Haulage	Belt Conveyor	Belt Conveyor	Belt Conveyor
Overburden Haulage	Truck	Truck	Belt Conveyor
PROCESSING			
Retorting	TOSCO II	TOSCO II	Combination of TOSCO II & Gas Combustion/Paraho
Upgrading	Thermal Cracking	Thermal Cracking	Delayed Coking & Hydrotreating
Processed Shale Haulage	Truck	Truck	Belt Conveyor
PRODUCTS			
Pipelineable Shale Oil	4,500 BPSD	9,000 BPSD	-
Upgraded Shale Oil	-	-	55,800 BPSD
Sulfur	11 LTPSD	22 LTPSD	153 LTPSD
Ammonia (anhydrous)	-	-	232 TPSD
Coke	-	-	467 TPSD
Moisturized Processed Shale	11,000 TPSD	22,000 TPSD	118,500 TPSD
WATER DEMAND	1,390 AFY	2,370 AFY	10,000 AFY
POWER DEMAND	17.7 MW	28.8 MW	227 MW
PEAK EMPLOYMENT			
Construction	700	400	2,200
Operation	300	500	1,100

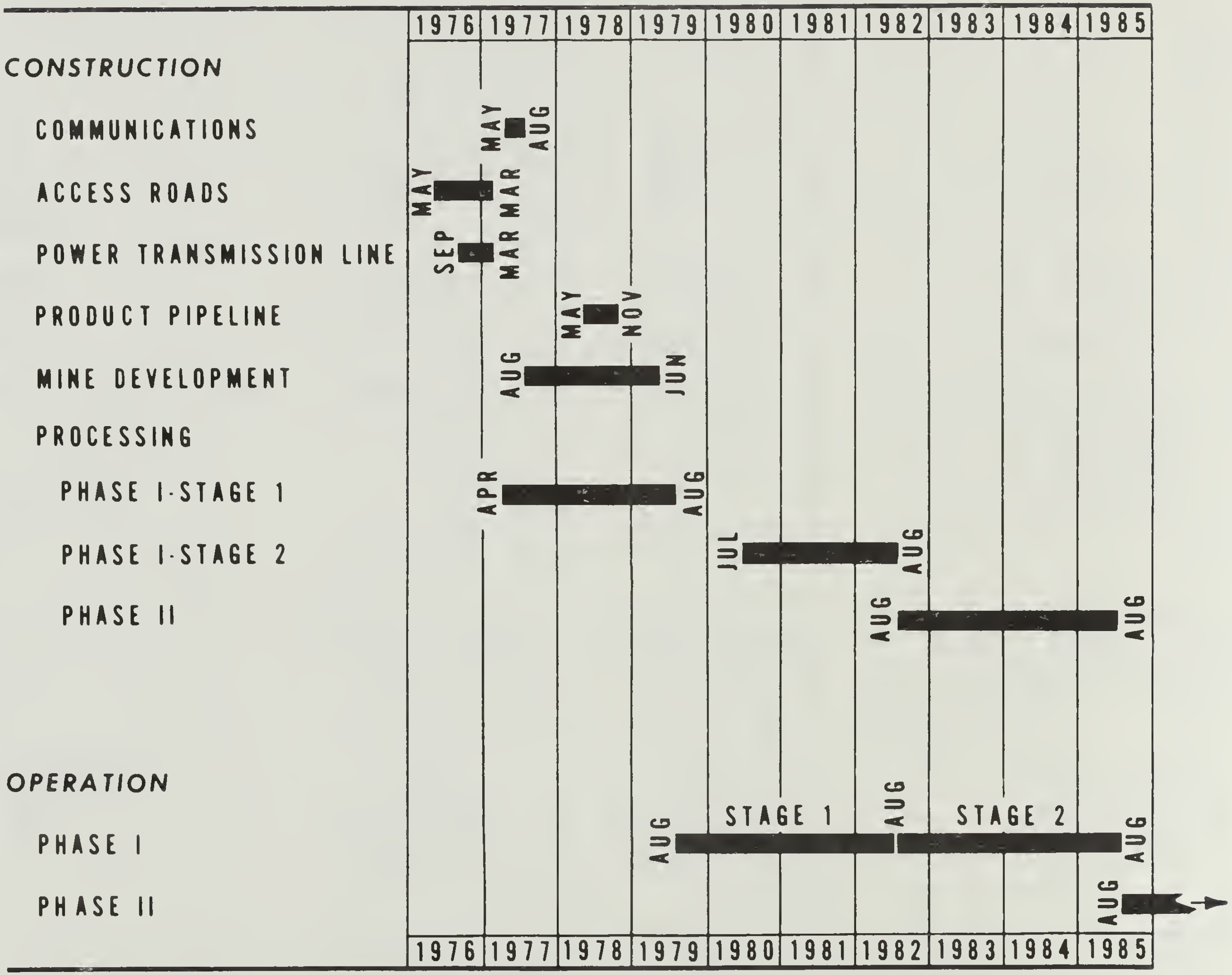


Figure 2-1-1

RBOSP CONSTRUCTION AND OPERATING SCHEDULE resource can be recovered from Tract C-a by open pit mining. From an environmental viewpoint, it is probable that one open pit operation will have less environmental impact in many ways than five underground operations with their attendant disposal areas, roads, communication lines, power lines and pipelines.

Selection of 84 Mesa as the location for processed shale and overburden disposal was based on an analysis incorporating environmental and operational comparisons among 16 potential disposal sites on and in the vicinity of Tract C-a. From an environmental standpoint, 84 Mesa ranked first among potential off-tract disposal sites and second overall. Operationally, 84 Mesa ranked first among all sites.

Selection of the processing facility site was based on a similar analysis and on the additional considerations that it should be located: (1) in relatively close proximity to both the mine and the 84 Mesa disposal site; (2) on a topographic high rather than in a valley in order to enhance dispersion of stack emissions; and (3) on relatively level ground. A site at the north edge of Tract C-a was found to best satisfy these requirements.

Ore will be transported from the mine to the processing facility by belt conveyor during both Phases I and II. Processed shale and overburden will be hauled to disposal by trucks during Phase I and by belt conveyors during Phase II. After about 30 years of Phase II operations, enough working space will have been created by mining to permit the backfilling of overburden and processed shale in the northwest portion of the open pit while mining continues in a southeasterly direction. As final slopes are established on the 84 Mesa disposal embankment, it will be progressively reclaimed so that within a few years after backfilling into the open pit begins, the disposal pile will have been completely contoured commensurate with surrounding topography and revegetated. Similarly, the backfilled portion of the open pit will be progressively reclaimed as operations proceed.

RBOSP's principal product (pipelineable shale oil in Phase I and upgraded shale oil in Phase II) will be transported by pipeline to Rangely, Colorado, thence through an existing Amoco pipeline to other connecting carriers for ultimate

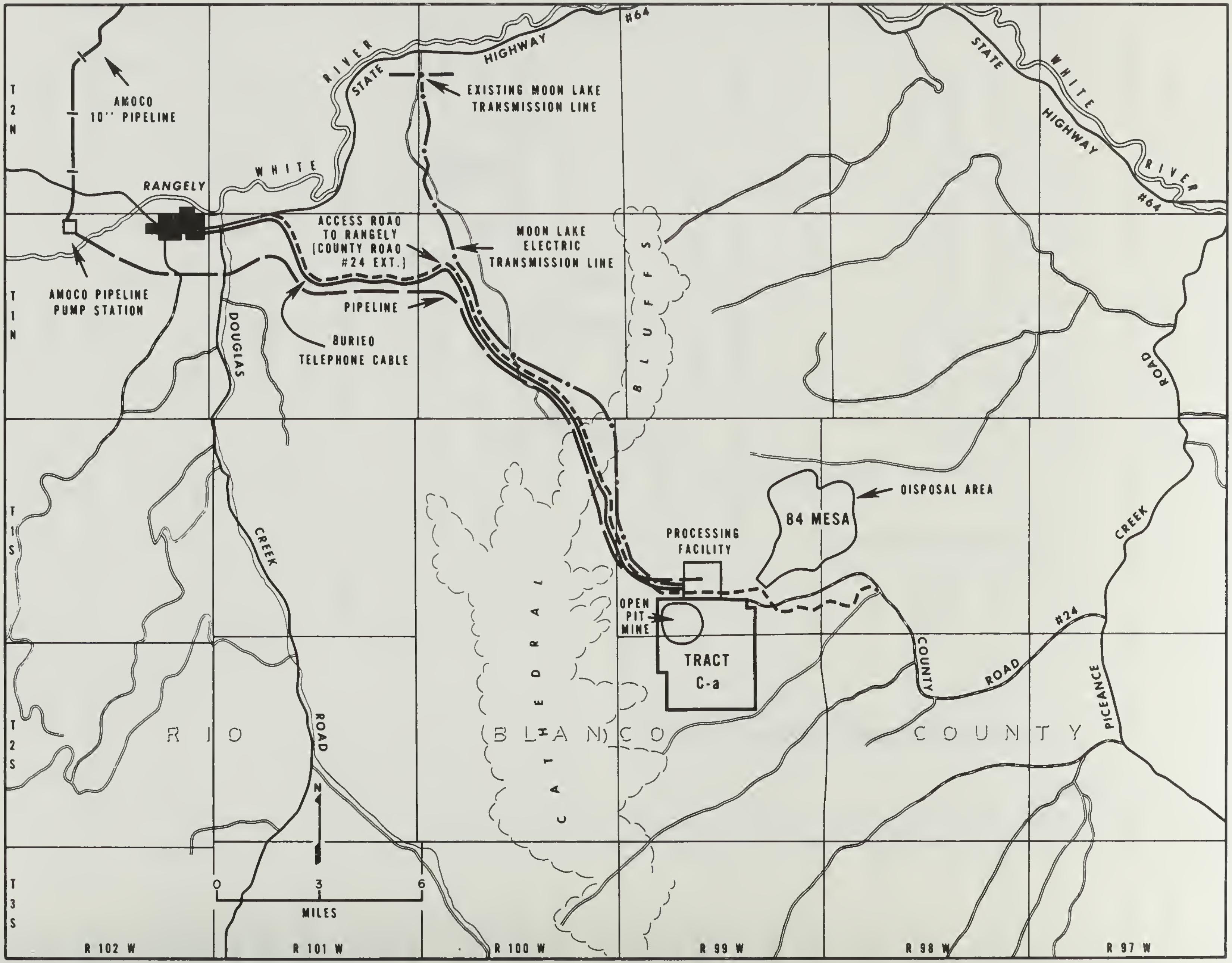


Figure 2-1-2

LOCATION OF RBOSP FACILITIES

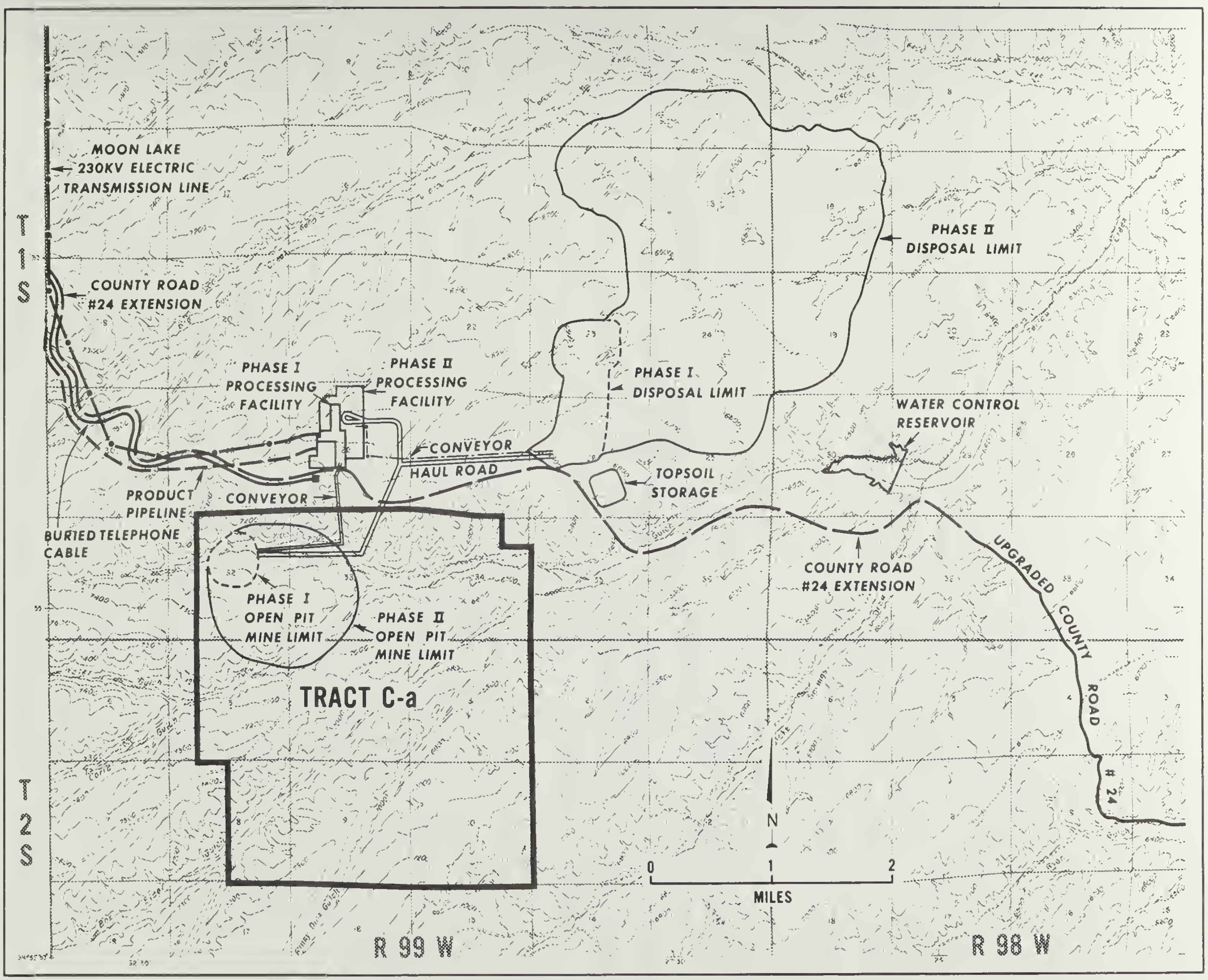

MOON LAKE 230KV ELECTRIC TRANSMISSION LINE
T 1 S
COUNTY ROAD #24 EXTENSION
PHASE I PROCESSING FACILITY
PHASE II PROCESSING FACILITY
PHASE I DISPOSAL LIMIT
PHASE II DISPOSAL LIMIT
WATER CONTROL RESERVOIR
CONVEYOR
HAUL ROAD
TOPSOIL STORAGE
PRODUCT PIPELINE
CONVEYOR
BURIED TELEPHONE CABLE
PHASE I OPEN PIT MINE LIMIT
PHASE II OPEN PIT MINE LIMIT
TRACT C-a
COUNTY ROAD #24 EXTENSION
UPGRADED COUNTY ROAD # 24
T 2 S
N
0
1
2
MILES
R 99 W
R 98 W

Figure 2-1-3

LOCATION OF RBOSP FACILITIES IN VICINITY OF TRACT C-a delivery to refineries in the West or Midwest; a possible exception to this plan is during Phase I when shale oil may be trucked to an existing refinery near Fruita, Colorado. By-products (sulfur, ammonia and coke) will be trucked from Tract C-a to rail facilities near Rifle, Colorado.

RBOSP employment during Phase I will be about 700 for construction, 300 for Stage 1 operations, and 500 for Stage 2 operations. Phase II construction employment will peak at about 2,200 while the Phase II operating force will total about 1,100 permanent employees. Overall RBOSP employment is expected to peak at 2,700 during the period from mid-1982 to mid-1985 when both Phase I - Stage 2 operations and Phase II construction are underway. Table 2-1-2 further summarizes RBOSP employment projections.

RBOSP water requirements will vary from about 1,400 acre-feet per year (AFY) during Phase I - Stage 1 to some 10,000 AFY during Phase II. Current data indicate that all water requirements through Phase II can be supplied from ground water sources on Tract C-a. Normal mine dewatering operations should provide most of the required amount, but some supplementary wells (all on Tract C-a) may be necessary.

Project power demand will be about 18 MW during Phase I - Stage 1 operations and will increase to some 227 MW during Phase II. Moon Lake Electric Association will supply electricity to Tract C-a via a 230-KV transmission line from an existing line near the White River some 20 miles north of the tract. Mountain Bell Telephone Company will provide communications via a buried telephone cable from Rangely. Vehicular access to Tract C-a will be via Rio Blanco County Road 24 (Ryan Gulch Road) from the east and via an extension of this road from the tract to Rangely on the west. The power transmission line, shale oil pipeline, telephone cable, and access road will be located, wherever possible, in a common corridor between Rangely and Tract C-a.

If Phase II operations prove to be environmentally, technically and economically successful, RBOSP may elect to increase production above 55,800 BPSD. Current RBOSP estimates indicate that Tract C-a reserves are adequate to support a shale oil production of up to 300,000 BPSD.

TABLE 2-1-2

RBOSP CONSTRUCTION, OPERATION AND EMPLOYMENT SCHEDULE

Dates	Activity		Peak Employment		
	Construction	Operation	Construction	Operation	Total
May '76 - Mar. '77	Access Road & Power Line	-	300	-	300
Apr. '77 - Aug. '79	Phase I - Stage 1 Product Pipeline	-	700	-	700
Aug. '79 - Jul. '80	-	Phase I - Stage 1	-	300	300
Jul. '80 - Aug. '82	Phase I - Stage 2	Phase I - Stage 1	400	300	700
Aug. '82 - Aug. '85	Phase II	Phase I - Stage 2	2,200	500	2,700
Aug. '85 and Beyond	-	Phase II	-	1,100	1,100

Employee Categories	Construction	Operations
Administrative, Management & Technical	15%	24%
Hourly	85%	76%

Anticipating this possibility, RBOSP is already taking initial planning steps in areas where long lead times are necessary, the most important of which is securing rights to adequate surface water supplies. In addition to more water, increased production would also require a larger processing facility--the Phase I and II processing facilities are located at a site where there is enough room for expansion. Additional off-tract lands for processed shale and overburden disposal would not be required since the void created during the first 30 to 40 years of Phase II mining will be sufficient to allow subsequent mining to stay ahead of backfilling operations, regardless of production rates.

Expansion beyond a Phase II production level of 55,800 BPSD is treated only conceptually in this development plan because detailed planning for such expansion (excepting the acquisition of water rights) cannot begin until Phase II is underway. Ultimately, however, maximum recovery of resource from Tract C-a (and thus, maximum resource conservation) can only be realized by completely mining the tract. Furthermore, leaving exposed mining faces at the south and east boundaries of Tract C-a would permit future developers on adjacent leases to continue open pit mining where RBOSP operations end.

1.3 CONSTRUCTION ACTIVITIES

Mine development and construction of retort feed preparation, processing, processed shale and overburden disposal, and support facilities will typically include the following steps, where applicable:

- Clearing and grubbing
- Salvaging topsoil
- Construction staking
- Rough grading
- Distributing power and water
- Excavating for foundations and underground facilities
- Placing concrete
- Erecting structural steel buildings
- Installing machinery

- Enclosing buildings
- Finish grading
- Installing interior wiring and piping
- Testing of systems and machinery

The major mining equipment--power shovels, rotary drills, and haulage trucks--will be assembled on-site at Tract C-a because of the size and weight of fully-assembled units. Similarly, many of the components in the processing facility--rotary kilns, heaters, heat exchangers, pumps, furnaces, compressors--must also be field-fabricated.

Construction activities will be coordinated to minimize land disturbance and to avoid unnecessary disturbance. Vehicular traffic will be restricted to established roads, wherever possible.

1.4 MAJOR ACTIONS NEEDED BEFORE RBOSP CAN PROCEED

Before RBOSP can proceed with development of Tract C-a, there are several actions that must be taken by county, local, state and Federal governments. One of these, of course, is approval of the detailed development plan by the Area Oil Shale Supervisor. Other actions include: approval for RBOSP to use off-tract lands for processed shale and overburden disposal and for processing; approval of rights-of-way for service corridors; construction of access roads; acquisition by the town of Rangely of land for town expansion; and state re-classification of air quality designation of the region where Tract C-a is situated.

In addition to the above actions, numerous permits for various aspects of the project must be issued by Federal, state and county governments. Also, an acceptable land trade should be consummated between RBOSP and the Colorado Division of Wildlife for the surface of certain lands on and around Tract C-a.

A. Approval of Use of Off-Tract Lands - The final EIS for the prototype oil shale leasing program clearly anticipated open pit mining and off-tract disposal for Tract C-a development. In Volume III, Chapter III, page 15, of the EIS, there appears the following paragraph concerning processed shale and overburden disposal:

> "Offsite disposal of overburden or spent shale might take place on Federal, state, or private lands. Permission to use Federal lands for disposal would require a Special Land Use Permit, issued by the Secretary of the Interior. Under 43 CFR 2920.4, each permittee will be required to pay to the Bureau of Land Management, in advance, a rental determined by the authorized officer as the fair market value of the privileges granted. Disposal on State or private lands would similarly be an expense to the lessee. The cost of shale oil will thus reflect the cost of any offsite disposal."

Subsequent to issuance of the EIS, the Solicitor of the Department of the Interior concluded that Special Land Use Permits cannot be used for offsite waste disposal and that the Secretary lacks authority to grant such use. Only the U.S. Congress can give the Interior Secretary the authority needed by enacting legislation that would amend the Mineral Leasing Act of 1920. Such legislation is now pending. S.2413 and H.R. 11163 would allow the Secretary of the Interior to grant a Federal oil shale lessee an additional Federal lease for lands outside the original oil shale lease for any purpose connected with development operations on the original lease, except mining.

Conditions for granting such a lease, as noted in the Senate and House bills, are: (1) maximum of 6,400 acres; (2) the Secretary's decision that the additional land is needed for proper operations; (3) that the lessee would be able to conduct all operations on the additional lease in an environmentally proper manner; (4) the Secretary's determination that the issuance of the additional lease is in the public interest; and (5) payment of an annual rent reflecting fair market value of the rights granted. Specifically mentioned as purposes for which the Secretary might issue an additional lease are the disposal of oil shale waste and other materials removed from the oil shale lease and, secondly, the building of plants, reduction works, and other facilities connected with operations on the oil shale lease.

B. Approval of Rights-of-Way for Service Corridors - Before operations on Tract C-a can begin, it is necessary to install a power transmission line, product pipeline, and buried telephone cable and to build or improve access roads to serve the tract. The proposed construction schedule for and routes of these facilities are shown in Figures 2-1-1 and 2-1-2, respectively.

The Bureau of Land Management (BLM), U.S. Department of the Interior, has the authority to issue right-of-way permits for all of these facilities. RBOSP has worked closely with the BLM in selecting routes that: (1) optimize environmental, aesthetic, technical and economic considerations; and (2) minimize land disturbance by locating all facilities in a common corridor wherever possible.

C. Construction of Access Roads - In addition to some new construction on and necessary improvements to the existing Piceance Creek and Ryan Gulch roads, it is highly desirable that a new access road be built between Rangely and Tract C-a before RBOSP development operations begin. RBOSP has conducted social and economic studies resulting in the conclusion that Rangely should logically be established as the residence of most RBOSP employees, rather than either Meeker or a new town. Rangely is an oil town--it didn't exist until the 1940's when development of the Rangely oil field began. Its current residents are accustomed to oil-related development and most want the infusion of oil shale workers.

If the Rangely access road is not built before Tract C-a development begins, RBOSP employees will be dispersed throughout the area with most employees probably going to Rifle or Meeker. The random nature of this population dispersal will make it much more difficult to implement social and economic planning. The tendency in such a situation is to allow people to settle and then develop remedial social welfare programs to solve resulting problems. RBOSP feels this is an extremely undesirable situation, one that can be avoided if the Rangely access road is constructed on a timely basis.

The current highway distance from Tract C-a to either Meeker or Rifle is slightly more than 50 miles, while the highway distance from Rangely to the tract is nearly 70 miles. The Rangely access road would cut highway distance from Rangely to the tract to about 25 miles. RBOSP has worked closely with the BLM, Rio Blanco County officials and the Colorado State Highway Department in selecting a design and location for the Rangely access road. Rio Blanco County has submitted a formal application for the right-of-way and has also formally requested state funding for the road from the state's oil shale lease bonus money. What is now needed is a formal state appropriation so that Rio Blanco County (under State Highway Department supervision) can build the road. The estimated cost of the Rangely access road is about $11 million.

The estimated cost of the new construction on and improvements to the Piceance Creek and Ryan Gulch roads is about $5 million. The Colorado General Assembly is considering the appropriation of funds for this purpose.

D. Land for Rangely Townsite Expansion - RBOSP expects that most of its employees will live in Rangely because of its close proximity to Tract C-a, provided the Rangely access road is built in a timely fashion. RBOSP has assisted the town of Rangely in community development planning through a contract with a Gulf subsidiary, Gulf Oil Real Estate Development Company and by financially supporting other planning programs.

Rangely is virtually surrounded by Federally-owned land administered by the BLM. To accommodate the increased population that will be caused by Tract C-a development, the area of Rangely will obviously have to increase; however, the legal machinery for allowing the town of Rangely to acquire land for residential purposes does not presently exist. Legislation now pending in the Colorado General Assembly would provide this machinery. Because the land needed (about 2,000 acres south and east of Rangely) is Federal land, Federal legislation may also be necessary. RBOSP believes that approval of such legislation is in the best interest of Rangely residents and the State of Colorado.

E. Resolution of Problems Concerning State and Federal Air Quality Standards - Analysis of baseline air quality data on and around Tract C-a reveals that Federal primary and secondary air quality standards for particulates, ozone, and non-methane hydrocarbons are occasionally being exceeded by background conditions existing in the Piceance Creek basin. This is not a unique situation. It is being encountered in many areas throughout the nation, particularly in the Southwest. It will thus be impossible to develop Tract C-a in accordance with the Federal Clean Air Act as now written. Amendments currently being considered by Congress will not solve the problem. Modification of the Clean Air Act is needed.

In the case of sulfur dioxide, RBOSP modeling studies indicate that Phase II operations on Tract C-a will meet currently-applicable ambient air quality and significant deterioration standards set by EPA. The Piceance Creek basin, however, is now classified by the State of Colorado as Category I and modeling indicates that Phase II RBOSP operations will not meet Colorado's current short-term ambient SO_2 standards. Operations would meet all applicable standards if the state redesignated the Piceance Creek basin as Category II.

CHAPTER 2

RATIONALE FOR MAJOR DECISIONS

Several different mining methods could conceivably be employed to develop Tract C-a, but RBOSP selected open pit mining because:

- It will result in a higher resource recovery than proven methods of underground mining.
- Technical uncertainties concerning underground room-and-pillar, bulk underground, and in situ or modified in situ recovery methods are too great at this point in time.
- Maximum resource utilization can be achieved in the Piceance Creek basin if the open pit created on Tract C-a ultimately becomes a starter pit for open pit mining on adjacent lands.

To optimize open pit development of Tract C-a, it is necessary to dispose of overburden, mine waste, and processed shale at a site off the tract. The site selected (84 Mesa) covers resource that is not believed to be amenable to open pit mining with current technology. Such off-tract disposal will permit maximum recovery of Tract C-a resources; this would not be possible if disposal were restricted to the tract. The 84 Mesa disposal site is all that is required, not only for Tract C-a development, but also for a migrating pit that could ultimately yield as much as 100 billion barrels of oil in the western and central portion of the Piceance Creek basin. RBOSP studies indicate that open pit mining with off-tract disposal is the preferable scheme for Tract C-a development from environmental, technical and economic viewpoints.

An off-tract location for the processing facility is also necessary for optimum development of Tract C-a by open pit mining. The site selected by RBOSP meets topographic and logistical requirements.

TOSCO II retorting has been selected for Phase I of Tract C-a development because it has been successfully demonstrated at a larger scale than any other retorting technology available. Full-scale development of Tract C-a (Phase II) will employ the best retorting technology available at the time Phase II begins -- based on current information, RBOSP believes this will be a combination of TOSCO II and gas combustion-type Paraho retorting. Both Gulf and Standard are participants in the Paraho Oil Shale Demonstration Project at the Anvil Points experimental facility near Rifle, Colorado.

RBOSP concluded that in situ technology is not far enough advanced to be seriously considered for initial operations on Tract C-a. As with all aspects of the project, however, RBOSP will continually monitor changing technology and incorporate new designs, operations, processes, or equipment wherever applicable. Gulf and Standard, for example, are participating in a multi-company experimental program in Utah (the WESTCO project) to study the feasibility of in situ recovery.

To summarize, RBOSP's major decisions concerning Tract C-a development include open pit mining, off-tract disposal of processed shale and overburden, off-tract processing, and a combination of TOSCO II and gas combustion-type retorting. The decisions to locate the disposal area and processing facility off Tract C-a are predicated on the selection of open pit mining. The selection of retorting processes, on the other hand, is not related to the other major decisions. Further rationale and justification for selecting open pit mining and off-tract disposal are offered in the following pages.

2.1 OPEN PIT MINING

There are a number of mining methods that might potentially be employed to develop oil shale, but as a result of a careful appraisal, RBOSP believes that only two are sufficiently proved to be seriously considered for initial operations on Tract C-a: open pit and underground room-and-pillar.

Prior to the prototype oil shale lease sales, the U.S. Department of the Interior estimated the recoverable reserves under Tract C-a to be 1.3 billion barrels by underground mining and approximately three times that amount, 4.07

billion barrels, by open pit mining. Since acquiring the Tract C-a lease, RBOSP has drilled 13 additional coreholes and conducted other studies which indicate that recoverable reserves from an open pit mine on Tract C-a will be nearly five times that expected from an underground room-and-pillar operation.

Room-and-pillar mining, shown conceptually in Figure 2-2-1, has been used to extract virtually all of the oil shale for experimental and pilot plant operations in western Colorado. If room-and-pillar mining were employed on Tract C-a, RBOSP's current information indicates that rooms would be from 40 to 100 feet high and that sills (the intervals between mining levels) would be about 100 feet thick. RBOSP geologic studies identified areas along faults where no resource recovery is thought to be possible by room-and-pillar mining.

Based on the dimensions currently envisioned, six levels could be mined within the approximately 1,000 feet of oil shale underlying Tract C-a. While every effort would be made to situate the mined intervals within the highest-grade ore beds, it would nevertheless be necessary to leave significant amounts of valuable ore as support pillars and sills. Resource recovery from underground room-and-pillar mining would thus be significantly lower than from open pit mining.

A schematic diagram of a typical open pit mining operation is shown in Figure 2-2-2. With open pit mining, it is possible to recover all of the commercial-grade oil shale underlying Tract C-a, except that oil shale contained in the trapezoidal-shaped zone ringing the perimeter of the pit -- the oil shale in this zone must be left in place at a slope of 45° to ensure stability of pit walls and to avoid having the pit extend beyond the boundaries of Tract C-a.

A comparison of Figures 2-2-1 and 2-2-2 clearly illustrates why resource recovery from Tract C-a will be substantially higher by open pit mining than by underground room-and-pillar mining. Open pit mining of oil shale will be similar to open pit copper mining practiced throughout the western United States.

MULTIPLE LEVEL – ROOM & PILLAR MINING CONCEPT

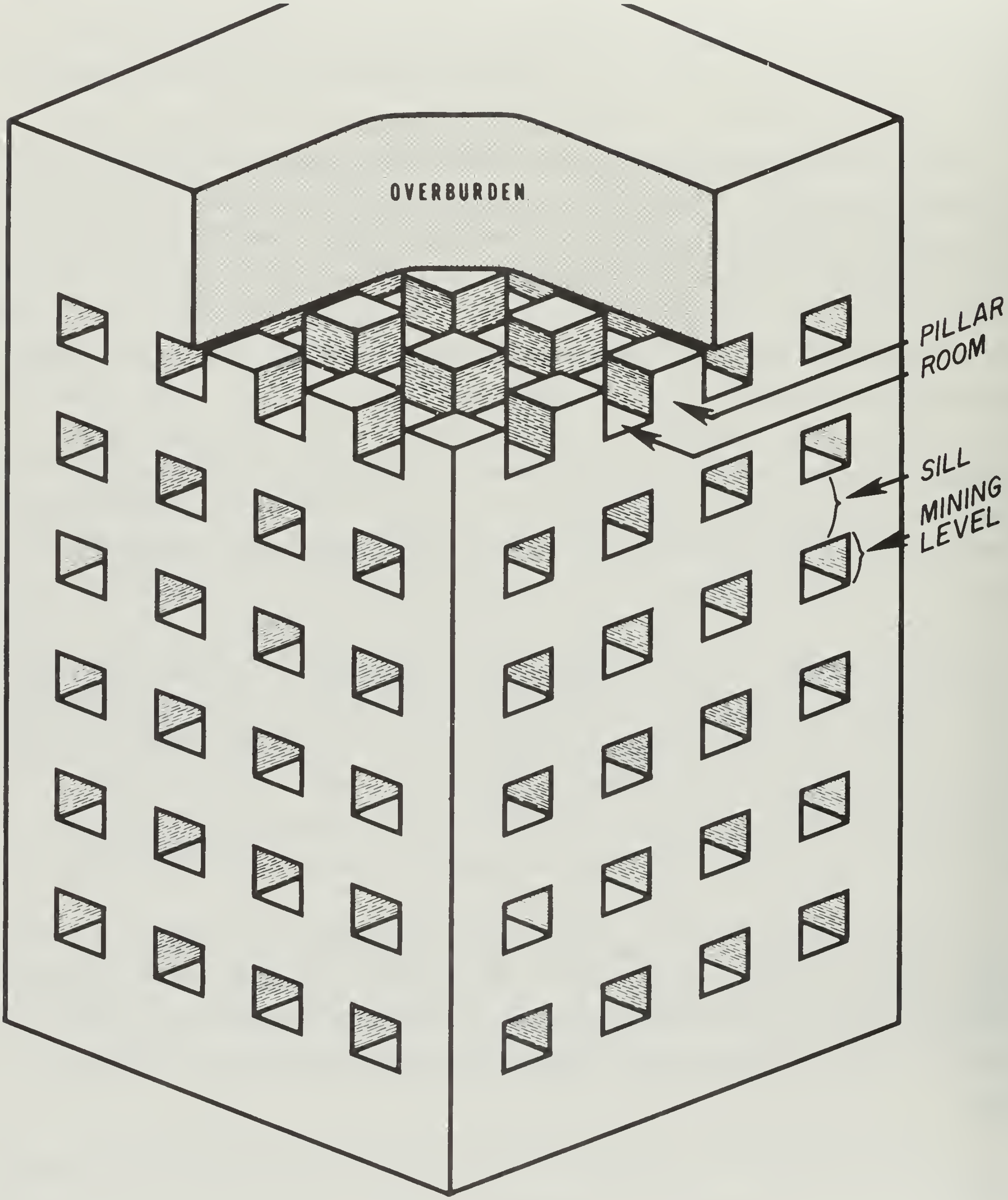
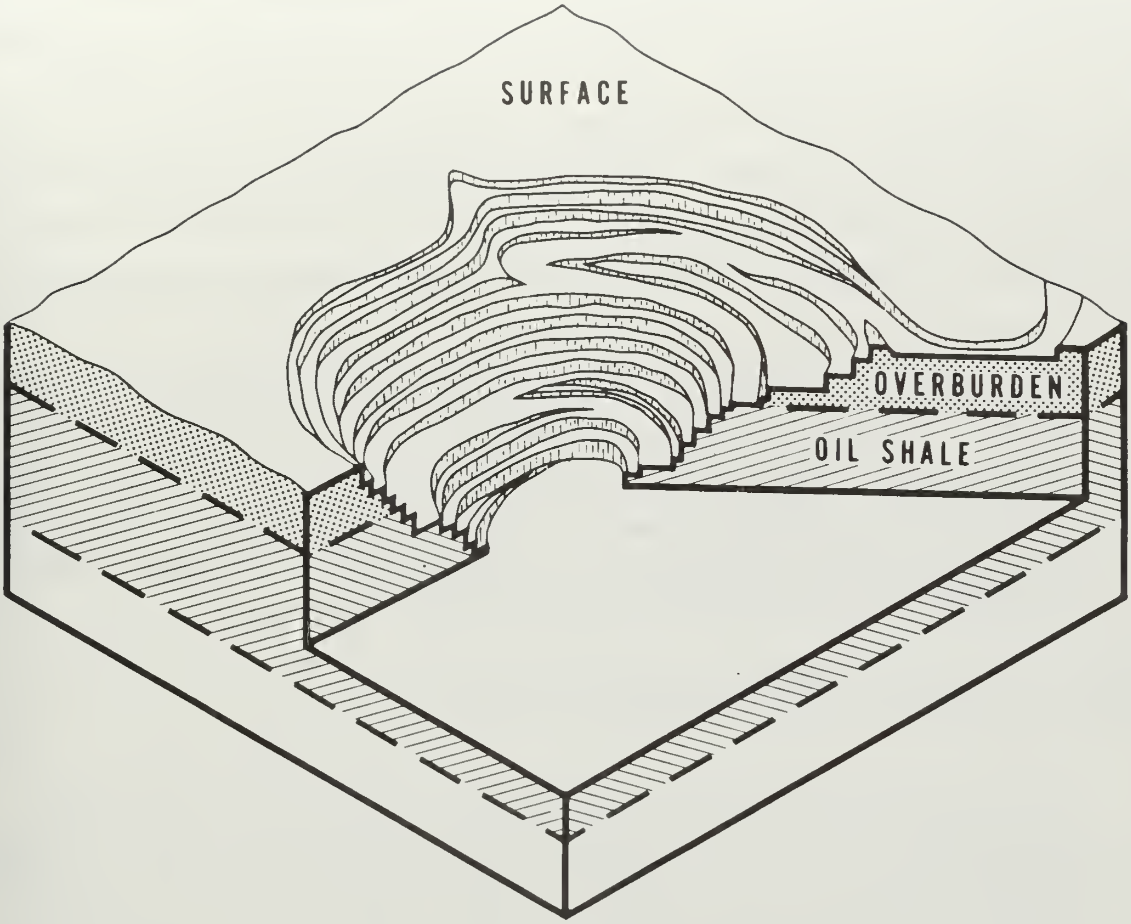
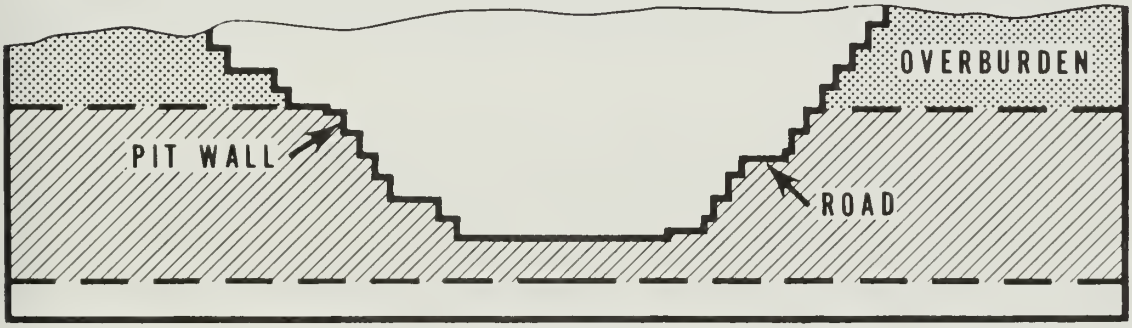


Figure 2-2-1
MULTIPLE LEVEL ROOM & PILLAR MINING CONCEPT



ISOMETRIC



SECTION

Figure 2-2-2
SCHEMATIC OPEN PIT DEVELOPMENT

The final environmental impact statement issued by the U.S. Department of the Interior in September 1973 for the Prototype Oil Shale Leasing Program clearly anticipated open pit mining and off-tract disposal of overburden and processed shale for Tract C-a development. Volume III of the EIS, entitled "Specific Impacts of Prototype Oil Shale Development," contains many references to open pit mining and off-tract disposal, especially in Chapter III, Mining and Processing Options on Selected Tracts, and in Chapter IV, Environmental Impact of Proposed Action. In Chapter IV, page 48, for example, the following appears:

> "If this tract [C-a] is mined by surface mining methods, it is expected that the entire surface would be excavated, leaving a different physical configuration than presently exists. At this time, the ultimate land form cannot be determined, since it will depend upon the particular mine and waste disposal system design, as well as the type of restoration adopted. If backfilling of the pit is employed, approximately the same elevation as the original surface may be expected after the operation is completed."

In Chapter III, page 11, the following is found:

> "Overburden ranging from about 100 feet to 800 feet in depth, and averaging 450 feet totals an estimated 7.1 billion tons for a pit laid out with a 1:1 final average slope (45 degrees). Of this amount, about 256 million cubic yards of loose waste material could be disposed of off-site in Water Gulch, which lies to the west of the tract. While this area has been delineated as a possible disposal site, it is not intended to conclude that Water Gulch will be used. Prior to selecting disposal sites, detailed engineering, geological and environmental studies would be conducted and submitted for approval. Because of the thickness of overburden in this area, future mining of oil shale would probably be by some type of underground method."

It is evident from the above quotations, that the Department of the Interior considered the possibility of open pit mining of all of Tract C-a, as shown by the 7.1 billion tons of overburden quoted in Chapter III, and by the statement in Chapter IV, concerning the entire surface being excavated. In writing the EIS, the authors did not have the benefit of detailed engineering studies of any particular tract, but nevertheless, they clearly saw the need for off-site disposal of overburden and processed shale for the initial pit opening prior to the time that backfilling could commence. It appears that the EIS authors did not state the need for the plant site to be located off the lease tract, but it is obvious from the statements about excavation of the entire surface, that this would be necessary.

2.2 PROCESSED SHALE AND OVERBURDEN DISPOSAL

As noted earlier, optimum development of Tract C-a by open pit mining can be achieved only if the disposal of overburden, mine waste and processed shale takes place off of the tract until there is enough room created in the open pit to permit backfilling of these solid waste materials into the pit without disrupting mining operations. The disadvantage of solid waste disposal on Tract C-a is that the deposited material would ultimately have to be rehandled as mining progresses, if the tract is to be completely mined by the open pit method. Rehandling overburden and processed shale has environmental, as well as technical and economic, implications. Once a disposal pile is reclaimed and vegetation is re-established, it is undesirable, from an environmental standpoint, to disturb the pile.

It would be possible, of course, to mine part of Tract C-a by open pit methods, pile the solid waste materials from that operation on the tract, then mine the remainder of the tract with the underground room-and-pillar method. RBOSP rejected this combined open pit/underground development scheme because resource recovery would be only about 25% greater than that expected from room-and-pillar mining exclusively, or still only about 25% of that expected from open pit mining.

2.3 MIGRATING OPEN PIT CONCEPT

Figure 2-1-3 shows the approximate Tract C-a open pit configuration and the 84 Mesa disposal area after about 30 years of operation at the Phase II shale oil production rate of 55,800 BPSD. It is at about this point in time that the open pit will be large enough to permit backfilling into the northwest quadrant of the pit while mining continues in a southeasterly direction. Figure 2-2-3

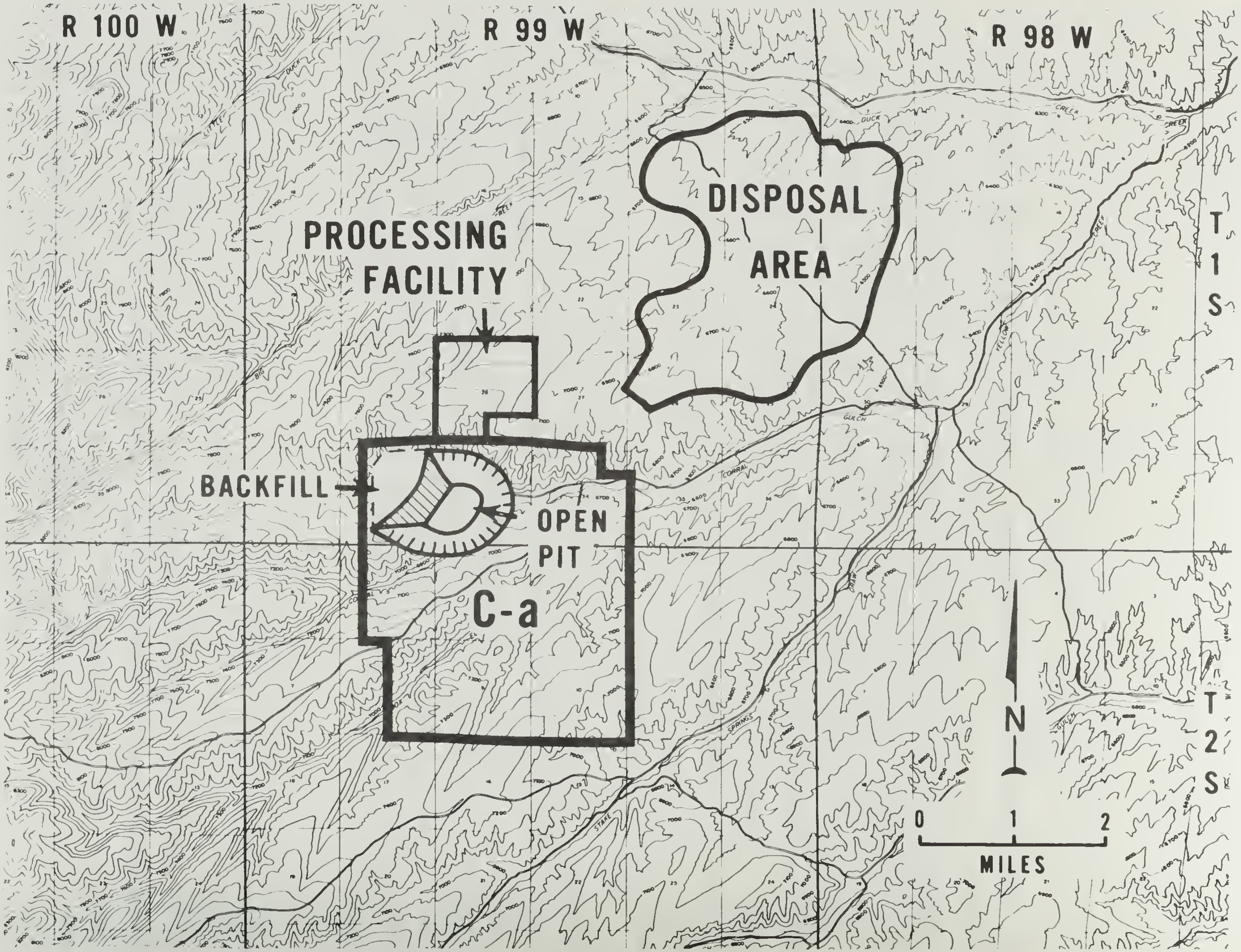


Figure 2-2-3

TRACT C-a WITH BACKFILLING

shows an approximation of how the pit might look a few years after backfilling begins. As noted earlier, the 84 Mesa disposal area will be progressively reclaimed so that shortly after pit backfilling begins, the disposal area will be completely rehabilitated. Similarly, the backfilled portion of the open pit will also be progressively reclaimed as mining progresses south and east across Tract C-a. The entire tract can be mined in this manner, and at any point in time, the size of the active pit area will be approximately the same as that shown in Figure 2-1-3. Furthermore, no additional off-tract lands are necessary for disposal after pit backfilling begins.

RBOSP has not conducted detailed engineering studies of the progression of a migrating open pit across Tract C-a, but Figure 2-2-4 shows the likely configuration of an ultimate open pit in the southeast corner of the tract. Depending on production rates, this configuration could be reached in several decades or a few hundred years. The important concepts shown in Figure 2-2-4 are that (1) the backfilled portion of the tract is rehabilitated, and (2) active pit walls are exposed at the south and east tract boundaries.

Application of the migrating open pit concept on lands adjacent to Tract C-a offers the opportunity for maximizing resource recovery from a significant portion of the Piceance Creek basin, in areas where the ratio of waste to ore is low enough to permit viable open pit operations. Figure 2-2-5 shows that portion of the Piceance Creek basin believed to be a prime area for open pit mining (cross-hatched area) and also shows how the Tract C-a open pit might have "migrated" at some time in the future. With active pit walls already exposed at the Tract C-a boundary, the open pit could simply migrate to the south and east if additional leases are issued. Operation of the migrating open pit would be essentially the same as that described above for operations on Tract C-a proper: overburden, mine waste, and processed shale would be backfilled into the already-mined pit area and progressively rehabilitated as mining continues.

If the migrating pit concept were adopted, the single disposal area on 84 Mesa, with an active life of about 30 years, should be the only out-of-pit area affected by disposal operations. If all of the area amenable to open pit

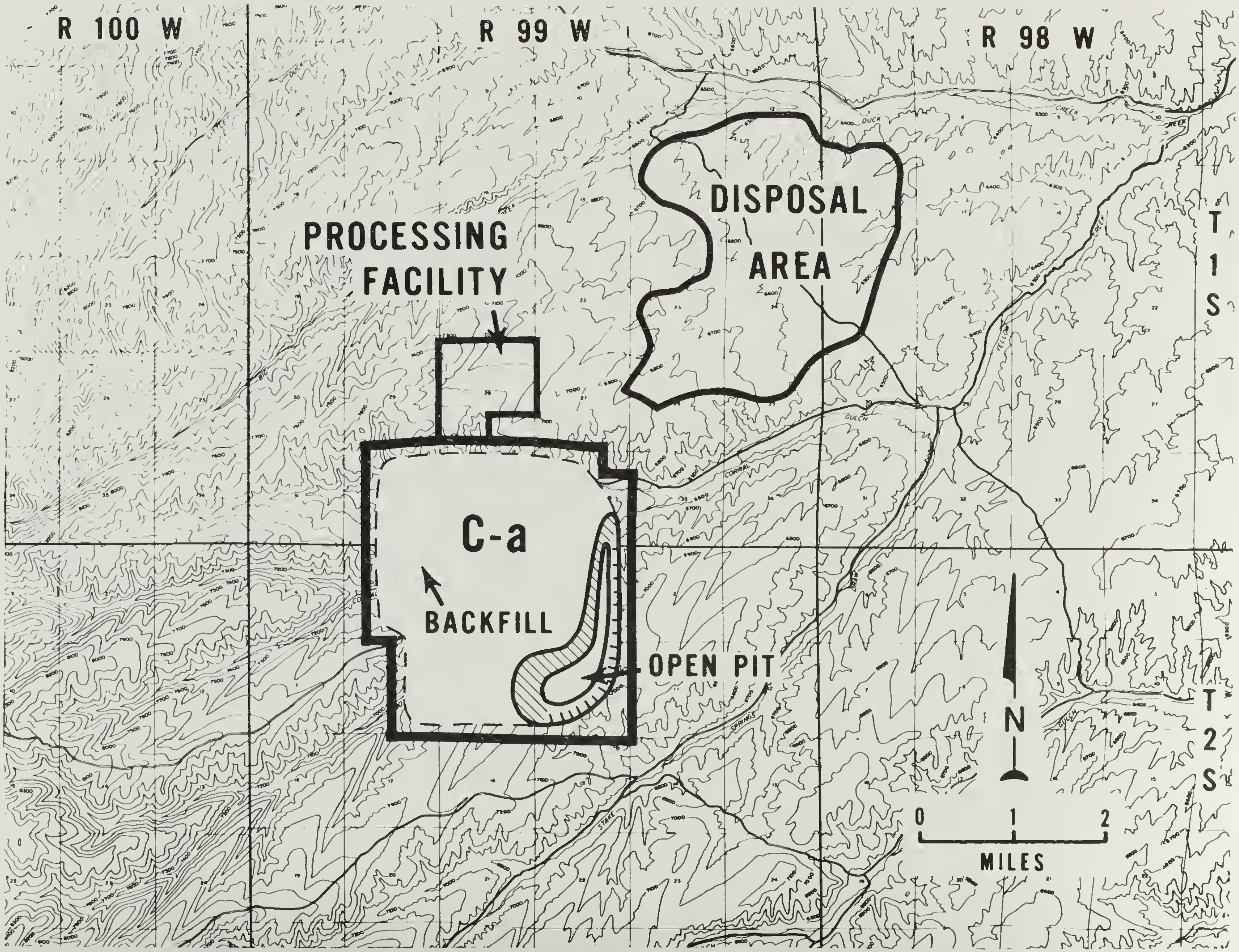


Figure 2-2-4

TRACT C-a ULTIMATE PIT WITH BACKFILLING

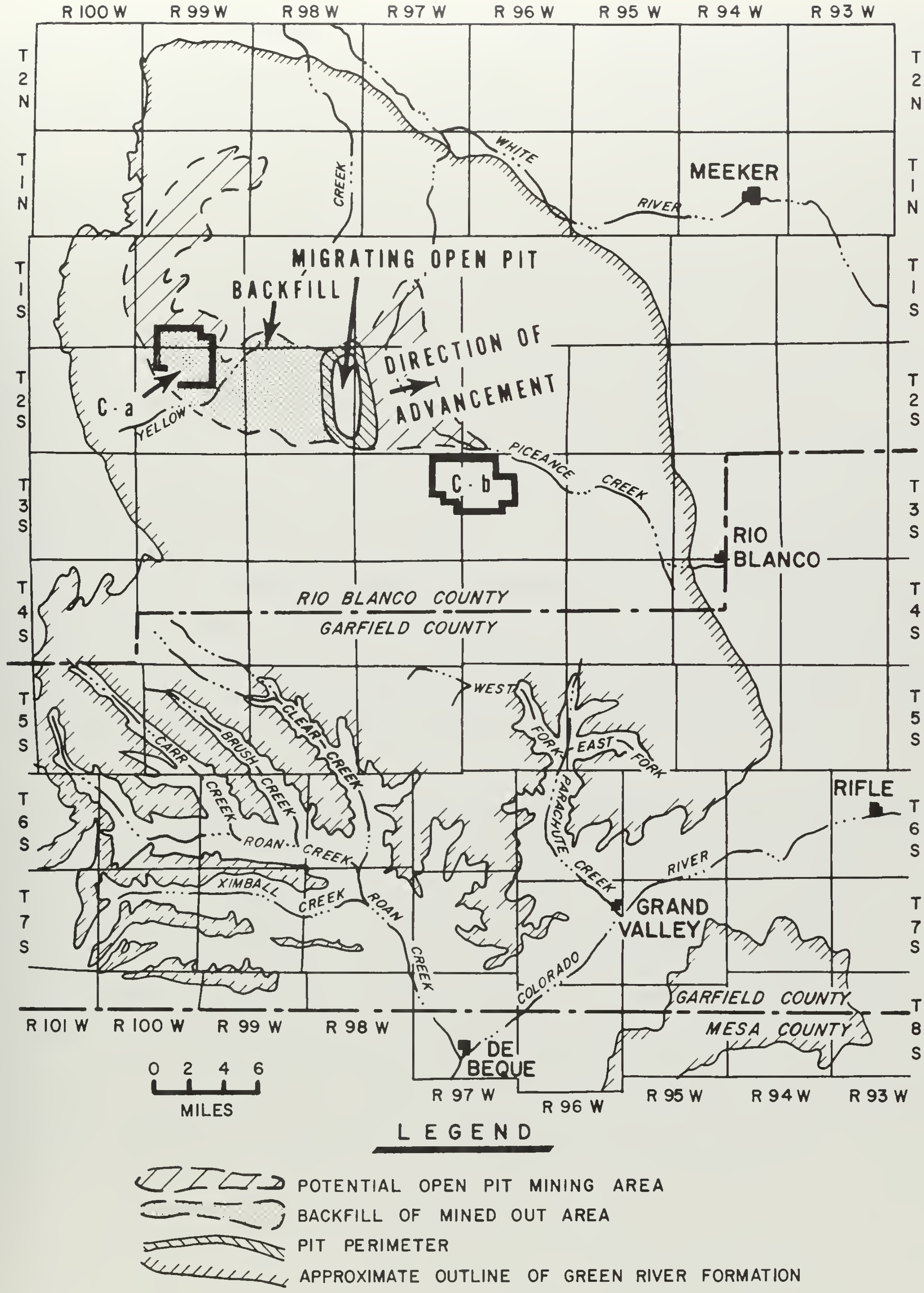


Figure 2-2-5

MOVING PIT CONCEPT, LATER PHASE SUCCEEDING TRACT C-a mining were developed in this manner, as shown on Figure 2-2-5, 100 billion barrels or more could perhaps be recovered over a long period of time. RBOSP feels it is important that this possibility not be precluded by restricting Tract C-a development.

CHAPTER 3
BASELINE CONDITIONS

3.1 INTRODUCTION

This chapter presents a description of the environmental setting of Tract C-a and vicinity. The Code of Federal Regulations [30 CFR 231.10 C (2)] requires that "a description of the location and area to be affected by the operations" be submitted as part of the mining plan. In addition, the environmental stipulation (Section 1.C.1) of the lease requires that the Lessee shall compile baseline data to determine conditions existing prior to any development operations. The lease and environmental stipulations specifically identify most of the programs described in the individual parts of this chapter. Other programs are described in order to develop a complete picture of Tract C-a and vicinity before development begins. The lease also states that the baseline data shall be collected for a period of at least two consecutive full years, one full year of which shall be prior to the submission of the development plan. Also, all records of baseline data shall be submitted to the AOSS.

The air quality, meteorology, terrestrial ecology and aquatic ecology programs are being conducted for a two-year period in order to establish the baseline. The information in this DDP covers the first year's work. The geology and hydrology programs are basically complete (except for required scheduled monitoring) and any additional work being done will be used to refine the baseline. The archaeology and paleontology programs have been completed. The trace metal and soil and overburden programs are presently under way; field work has been completed, samples are being analyzed, and data reduction and final analyses are being done. The chapter on ecosystem interactions describes ecological interrelationships based on information gathered to date.

3.2 GENERAL DESCRIPTION OF PROJECT AREA

Tract C-a is located in northwest Colorado, almost exactly midway and slightly south of a line between Denver and Salt Lake City. More specifically, the tract lies in the western third of Rio Blanco County, about 20 miles southeast of Rangely, 35 miles southwest of Meeker and some 55 miles due north of Grand Junction. The location of Tract C-a is further illustrated in Figures 2-3-1 and 2-3-2.

The specific lands covered by the Tract C-a lease amount to about 5,100 acres and are legally described as:

T. 1 S., R. 99 W., 6th P.M.
Sec. 32: E1/2, E1/2W1/2
Sec. 33: All
Sec. 34: W1/2, SE1/4, W1/2NE1/4, SE1/4NE1/4

T. 2 S., R. 99 W., 6th P.M.
Sec. 3: All
Sec. 4: All
Sec. 5: E1/2, E1/2W1/2 (incl. Lots 1, 2 and 3)
Sec. 8: E1/2
Sec. 9: All
Sec. 10: All

A. Topography and Cultural Features - Tract C-a is situated on the west flank of the Piceance Creek basin about five miles east of the Cathedral Bluffs. The term "Piceance Creek basin," as used here, serves to identify an area of approximately 1,600 square miles that is bounded on the north by the White River, on the east by Government and Sheep Creeks, on the south by the Colorado River and Roan Creek, and on the west by Douglas and East Douglas Creeks.

Physiographically, the Piceance Creek basin is part of the Colorado Plateau province. Because the basin was subjected to extreme vertical uplift in relatively recent geologic time, it now appears, in relief, as a large shallow bowl lying atop the Roan Plateau. The edges of the basin lie near the rim of the plateau and, as a result, streams draining the exterior faces of the plateau are short, few in number, and exhibit steep gradients while Piceance and Yellow Creeks and their tributaries, which drain the basin proper, are longer and more gently sloping.

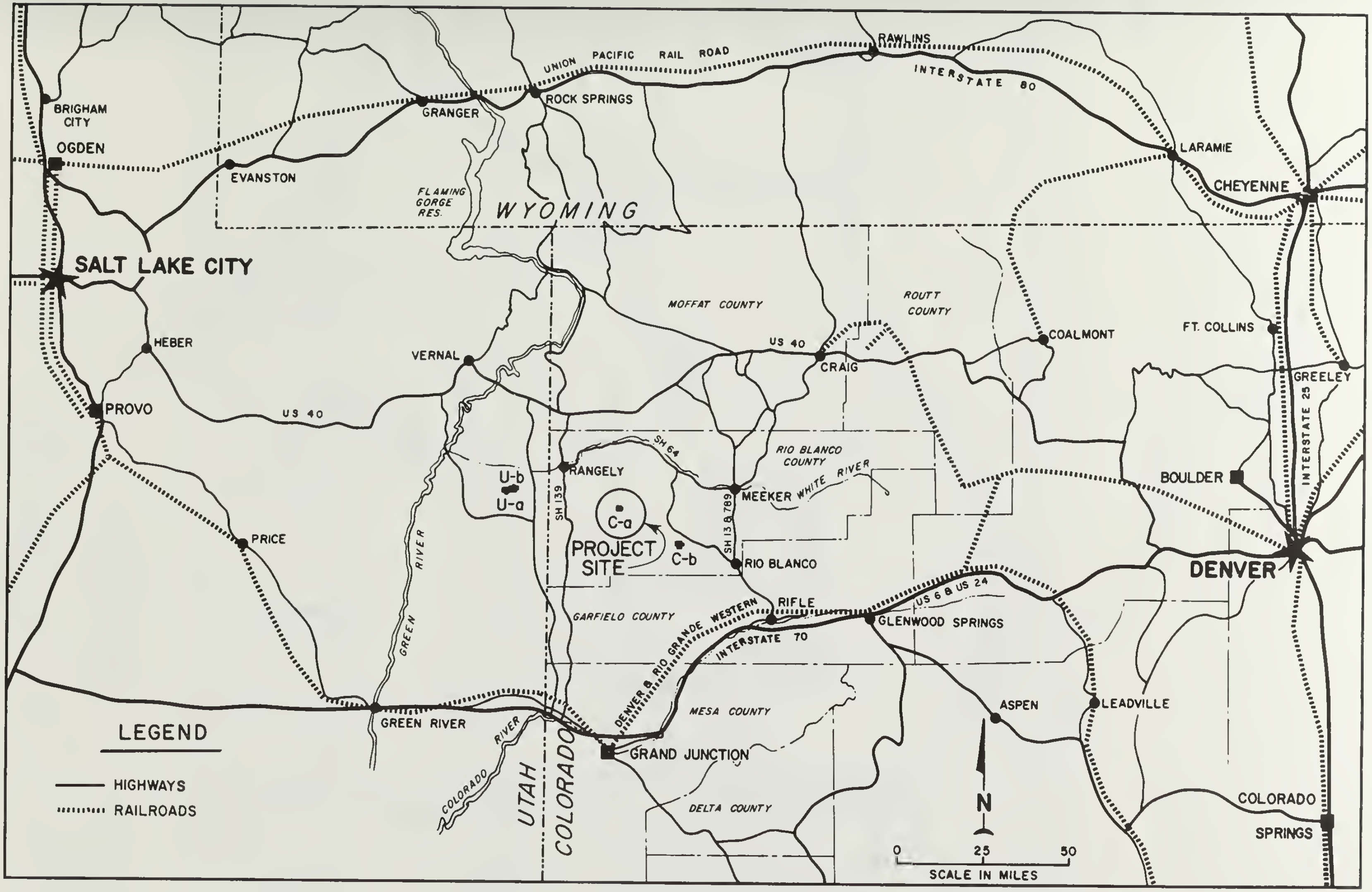


Figure 2-3-1

REGIONAL MAP SHOWING LOCATION OF TRACT C-a

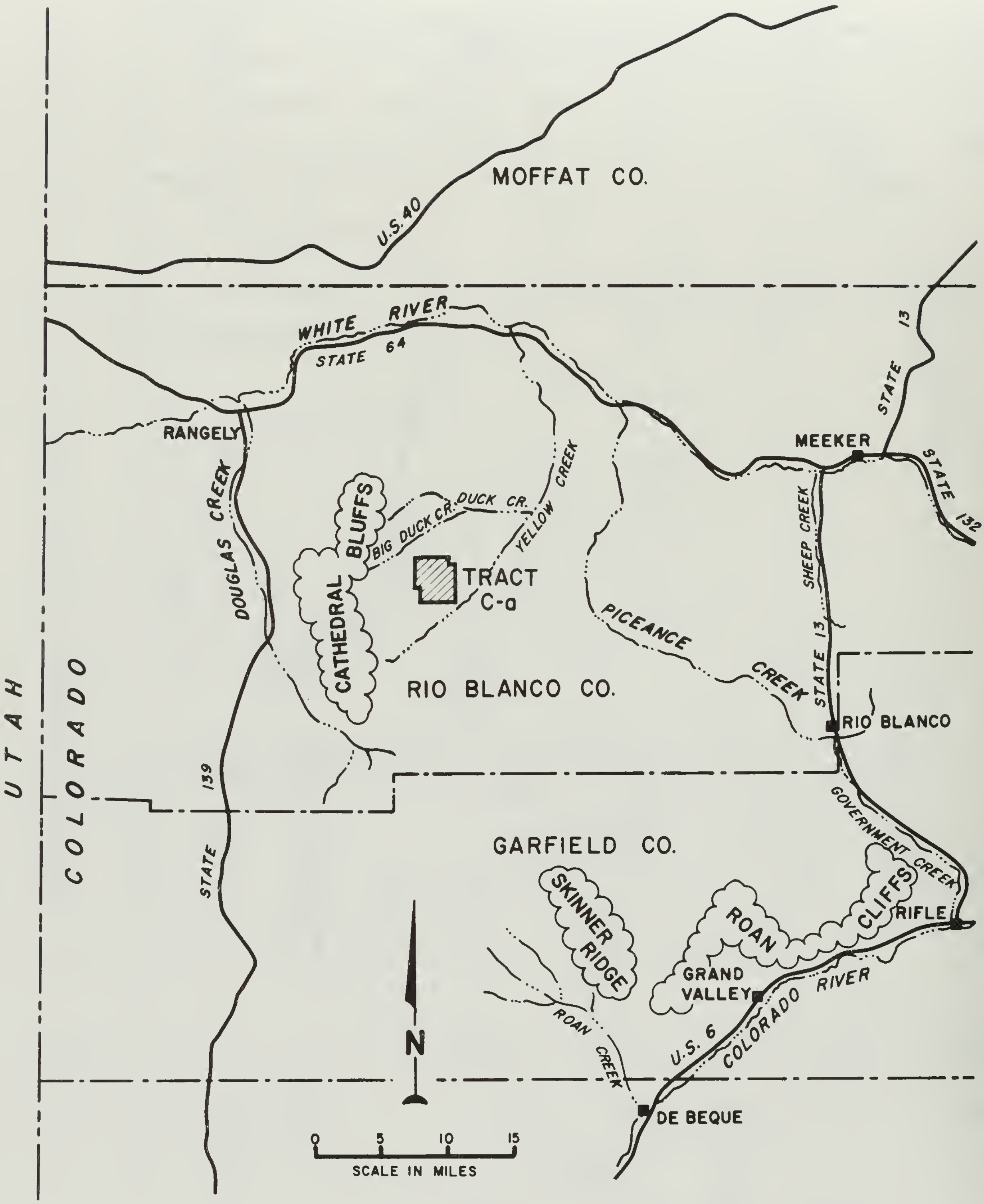


Figure 2-3-2

LOCATION MAP OF TRACT C-a

The basin's topography is characterized mainly by a series of nearly parallel north and northeasterly trending ridges and valleys with local elevation differences ranging from 200 to 600 feet. Piceance Creek, Yellow Creek, and tributaries of Douglas and Sheep Creeks drain the northern part of the oil shale area and are tributaries of the White River. Parachute Creek, Government Creek and Roan Creek drain the southern part of the oil shale area into the Colorado River.

Tract C-a topography is characterized by northeast-trending subparallel canyons and ridges. Slopes of northern canyon walls are typically steeper than southern walls. Valley floors are narrow and ridges are broad and rounded; both slope gently northeastward. Surface elevations vary from about 6600 feet in Corral Gulch near the northeast corner of the tract to slightly more than 7400 feet on Airplane Ridge near the southwest corner of the tract. The average elevation difference between valley floors and nearby ridge tops is about 300 feet. The valleys and ridges crossing Tract C-a originate to the southwest in the vicinity of the Cathedral Bluffs which rise to elevations varying between 8400 and 8700 feet. Most of Tract C-a is drained by Corral and Box Elder Gulches, which join just east of the tract and eventually intersect Stake Springs Draw to form Yellow Creek about 3-1/2 miles east of the tract. Stake Springs Draw drains the southeast corner of the tract.

Yellow Creek flows northeast from its origin but eventually curves to the northwest before emptying into the White River about 20 miles north of Tract C-a and at an elevation of some 5500 feet.

The first principal drainage north of Tract C-a is Duck Creek which flows into Yellow Creek about seven miles northeast of the tract. On the south, Ryan Gulch passes within about 2-1/2 miles of the southern boundary of Tract C-a before meeting Piceance Creek about 10 miles due east of the tract, where the elevation is about 6100 feet.

Few man-made features occur on or in the vicinity of Tract C-a. The Shields-Caldwell Hunting Camp near the confluence of Corral Gulch and Dry Fork are the only old buildings on the tract. In 1975, RBOSP built a small reception center in the extreme northeast corner of the tract. There are no other structures of any significance on the tract. The remains of the 84 Ranch headquarters are located about three miles east of the tract. The nearest structure or site of special historic significance is the historic Ryan Gulch School about five miles east of the tract. The only occupied dwellings in the area are at the Reagle Ranch headquarters on Ryan Gulch about three miles southeast of the tract.

Elsewhere in the vicinity of Tract C-a, the area is interspersed with primitive roads and trails; a gas pipeline that crosses the southeast corner of the tract, then parallels Stake Springs Draw for several miles before crossing the Cathedral Bluffs; a power transmission line some five miles west of the tract; several miles of fence at various locations; and several improved springs, check dams and small reservoirs. The nearest improved road is Rio Blanco County Road 24 in Ryan Gulch. The only paved highways in the vicinity are the Piceance Creek road to the east, the Douglas Pass road (State Highway 139) to the west, and State Highway 64 between Rangely and Meeker to the north, There are also several conventional natural gas wells scattered throughout the area southeast of Tract C-a. Topography and cultural features on and around Tract C-a are further illustrated on Figure 2-3-3.

B. Land Use - The principal current activities in the Piceance Creek basin are ranching and stock grazing, big game hunting, and conventional oil and gas field development. Haying is confined to drainage bottoms but stock grazing (primarily cattle) is conducted throughout most of the area.

Although the basin proper is relatively isolated and virtually uninhabited (except for the Piceance Creek valley), accessibility is good. Even so, big game hunting in October and November comprises by far the majority of the recreational use of the area. It is one of the most popular deer hunting areas in Colorado. Fishing, on the other hand, is nonexistent in the area including and immediately surrounding Tract C-a. The nearest sport fishing of any importance is on the White River and the extreme lower reaches of Piceance Creek. Fishing is far more attractive farther up the river in the White River National Forest. Fishing and other recreational pursuits are of minor importance compared to big game hunting.

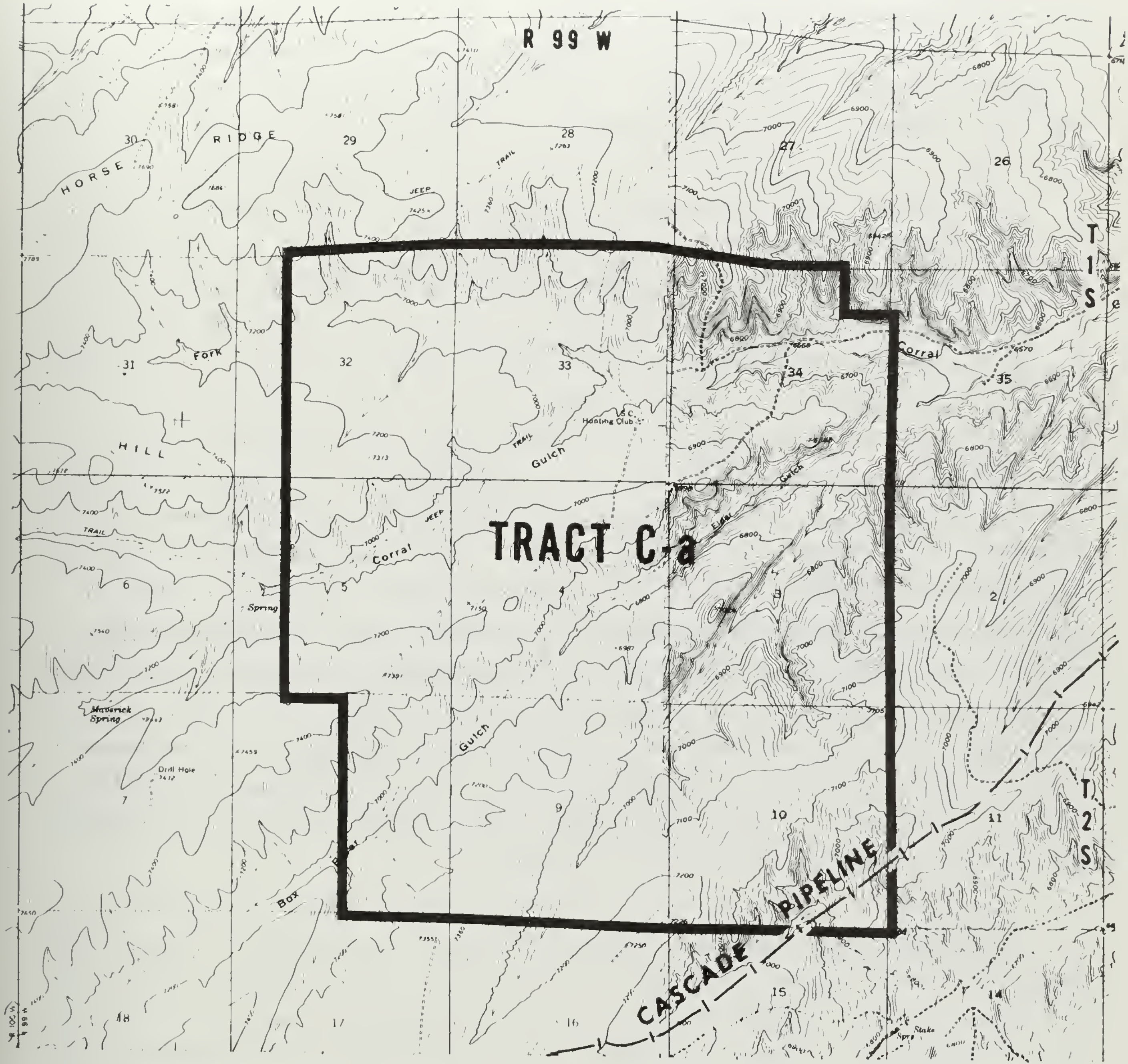


Figure 2-3-3
TOPOGRAPHY & CULTURAL FEATURES

While the Piceance Creek basin may be characterized as a beautiful and relatively unspoiled natural setting, it is not particularly spectacular scenery, nor does it contain any exceptional natural, archaeological, or historical sites. The fact that the Piceance Creek basin is not attractive to tourists and others pursuing outdoor recreational experiences is also attributable to the close proximity of many well known areas such as:

- Dinosaur National Monument
- Black Canyon National Monument
- Flaming Gorge National Recreation Area
- White River National Forest
- The Colorado Rockies

3.3 GEOLOGY

To define Tract C-a geology, RBOSP conducted an extensive data gathering program which included: aerial photography, photogeologic mapping, surface geologic mapping, topographic mapping, core hole drilling, laboratory analyses, seismic exploration and data compilation. This program has resulted in a refined geologic definition of Tract C-a and provided the resource data necessary for detailed engineering and formulation of the detailed development plan. Tract C-a geology as discussed here deals only with those stratigraphic intervals pertaining to tract development, namely, the oil shale-bearing Green River Formation and the overlying Unita Formation.

A. Stratigraphy - The oil shale underlying Tract C-a was deposited in the eastern portion of ancient Lake Uinta during Eocene time. The term "oil shale" is actually a lithologic misnomer because the rock is not shale nor does it contain oil in the conventional sense. Most oil shale is dolomitic marlstone containing variable amounts of organic matter (kerogen) derived chiefly from algae, aquatic organisms, waxy spores and pollen grains. This organic matter is only slightly soluble in ordinary petroleum solvents, but a large part can be converted to synthetic oil by destructive distillation.

Figure 2-3-4 is an updated generalized stratigraphic column of Eocene rocks in the Piceance Creek basin showing the relative stratigraphic position of the major Eocene units as well as intervals containing oil shale and several key stratigraphic markers. Several of the key stratigraphic markers provide convenient boundaries which segregate major lithologic units within Tract C-a. The Orange marker to Blue marker is the uppermost part of the Douglas Creek-Garden Gulch Members (undifferentiated) and consists mainly of light gray to brownish gray oil shale with lesser amounts of gray shaley siltstone. The overlying interval from the Blue marker to A-groove is the main oil shale interval of the lower Parachute Creek Member of the Green River Formation which consists mainly of dolomitic marlstone with varying amounts of kerogen. The upper part of the Parachute Creek Member lying above the A-groove is mainly light gray to medium brown oil shale grading upward into light gray barren marlstone interbedded with gray siltstone and fine grained sandstone. The overlying Uinta Formation covers most of the tract's surface and consists mainly of brown to light brown fine-grained massive sandstones with lesser amounts of siltstone.

Based on a subsurface correlation network, an oil shale zonation was established for Tract C-a resulting in the delineation of 19 zones, 9 rich and 10 lean. Figure 2-3-5 is a core hole histogram cross section of Tract C-a showing the alternating rich (R-0 through Mahogany and R-8) and lean zones (L-00 through L-8). Basically, the rich zones were established to include as much 17 GPT oil shale as possible and maintain stratigraphic continuity.

Acid extractable alumina is present in all 19 rich and lean oil shale zones. USBM x-ray diffraction analyses of core samples show that dawsonite and nordstrandite occur in a stratigraphic interval from the upper part of the R-2 zone through the lower part of the R-5 zone. Analcime was found to occur stratigraphically above and below the dawsonite-bearing interval, generally in higher concentrations.

Within Tract C-a, limited amounts of nahcolite occur as thin beds, stringers, nodules and coatings or small crystal growths on both vug walls and shale partings. The few scattered beds present are usually less than one foot thick

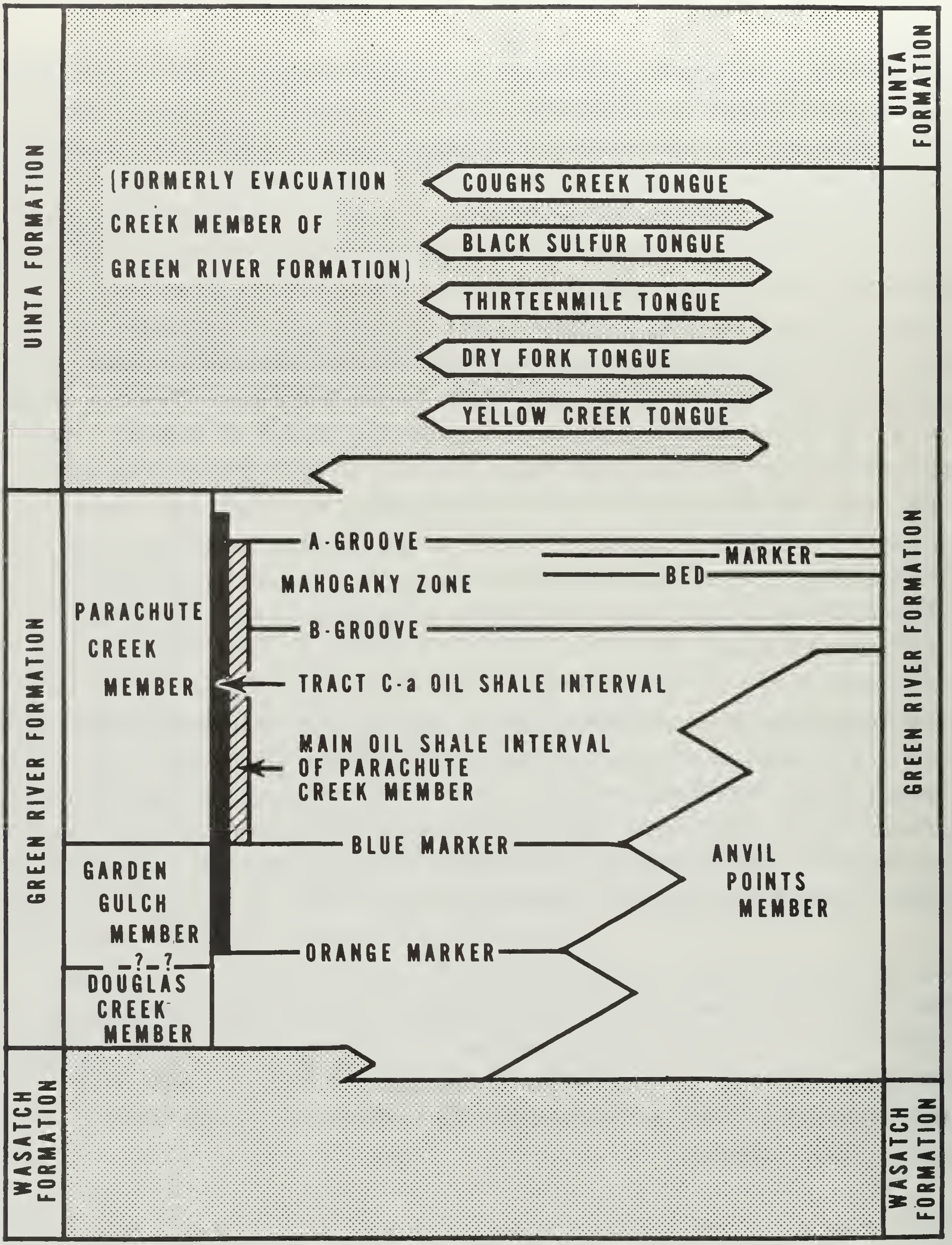


Figure 2-3-4

GENERALIZED STRATIGRAPHIC COLUMN OF TERTIARY EOCENE SERIES, PICEANCE CREEK BASIN

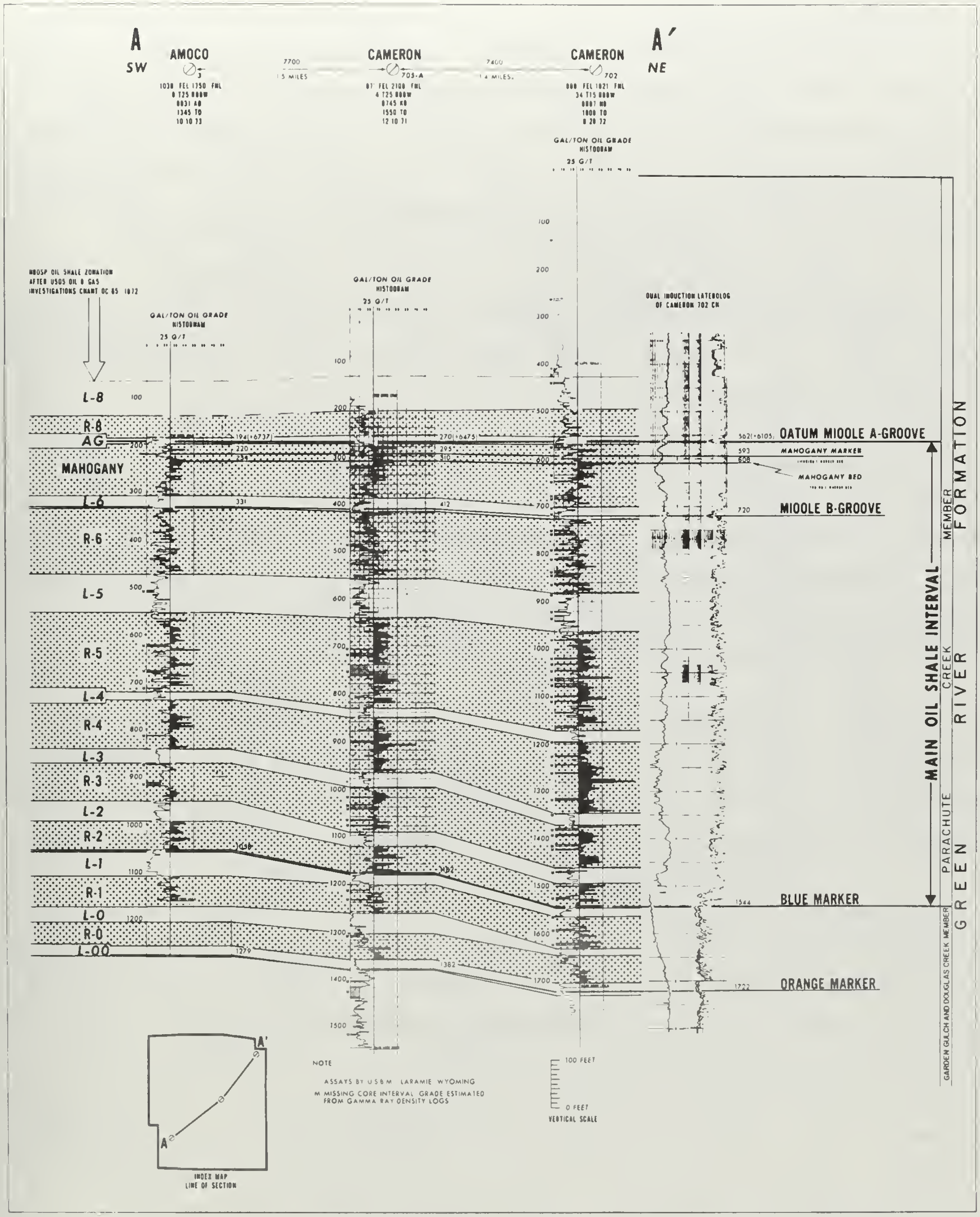


Figure 2-3-5

SW-NE 3-CORE HOLE HISTOGRAM CROSS SECTION, TRACT C-a with a maximum thickness of two feet. Primary deposition of nahcolite within Tract C-a was apparently limited to nodules and a few relatively thin beds and stringers. Subsequent removal of the water-soluble nahcolite by ground water leaching has reduced its original concentrations within the tract considerably resulting in many vugs or solution cavities. As a result, the minor occurrences of nahcolite remaining in the Tract C-a oil shale interval have no commercial value.

Both methane and hydrogen sulfide have been detected in the oil shale sections within Tract C-a. The gases probably occur trapped in vugs and fractures as well as dissolved in the ground water.

Trace element quantitative analyses were run for antimony, arsenic, boron, cadmium, fluoride, mercury, and selenium in both fresh and processed oil shale as well as fresh overburden. The results of the analyses indicate that for fresh oil shale: antimony, mercury, and selenium concentrations average less than one part per million (ppm); arsenic and cadmium average a few parts per million; and boron and fluoride average a few hundred ppm.

B. Structure - The Piceance Creek basin is a broad northwest-trending structural trough, the central part of which contains the Green River Formation underlying an area approximately 60 miles long and 40 miles wide. Green River Formation sediments around the basin's periphery have been removed by erosion.

Tract C-a is located on the west flank of the Piceance Creek basin about five miles east of Cathedral Bluffs. Beds within the tract strike generally to the north and dip basinward to the east and northeast at an average rate of 200 to 350 feet per mile (2-4°) except where locally disturbed by folds and faults. The present day structural framework of Tract C-a is dominated by the Sulfur Creek anticlinal nose and three major en echelon fault systems (graben) on its northeast flank. Four minor folds and multiple subsidiary faults complete the framework. Figure 2-3-6 is the middle A-groove structure map showing the structural features of Tract C-a. The Sulfur Creek anticlinal nose is a gentle low relief structure which plunges southeastward through the southern portion of the tract. The three northwest-trending en echelon graben essentially parallel the Sulfur Creek anticlinal axis. Fault displacements on Tract

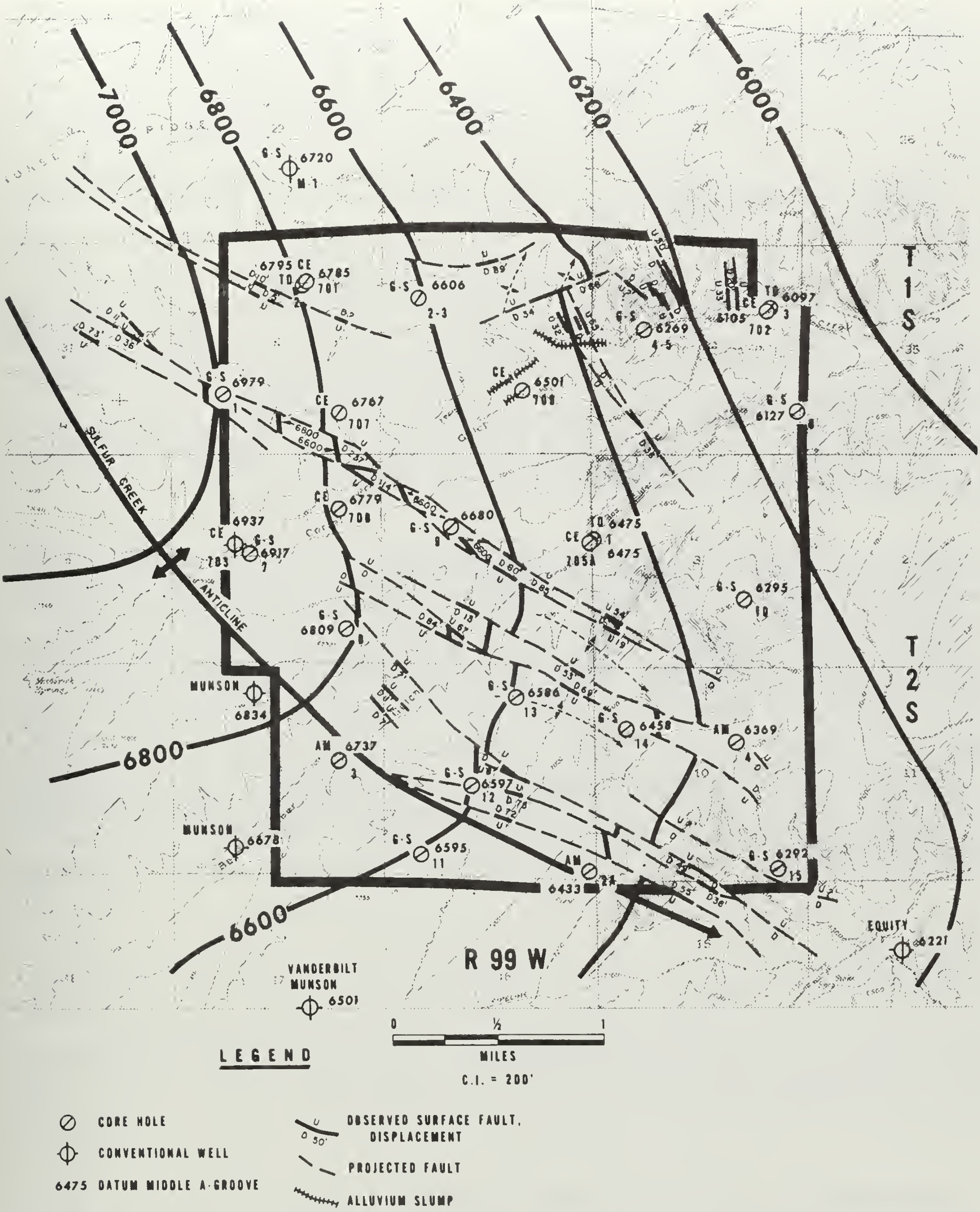


Figure 2-3-6

RBOSP TRACT C-a MIDDLE A-GROOVE STRUCTURE MAP

C-a range from a few to more than 230 feet. The northernmost graben is the most structurally complex. The combination of cross faulting within the graben together with differential displacement on the graben-bounding faults provide strong evidence that this graben is not one simple downthrown block, but rather a series of broken and tilted (rotated) blocks between the graben-bounding faults.

A joint system consisting of three main joint sets and, locally, a fourth set is present within Tract C-a; joints in each set are generally spaced ten feet or more apart. The dominant set strikes N56°-76°W with dips of 74°SW passing through vertical to 86°NE. The secondary set strikes N28°E with a dip of 80°NW. The tertiary set strikes N15°W with a dip of 75°E. The local fourth set strikes N84°W and dips 82°N passing through vertical to 85°S.

C. Overburden - Overburden thickness between ground surface and the middle A-groove horizon varies considerably throughout the tract dependent upon abrupt local changes in topographic relief. This variable topography together with the general east and northeast gentle dip of the subsurface middle A-groove horizon results in a generally northeast trending grain to the overburden. Overburden thickness ranges from about 60 feet to 875 feet with a tract average of about 480 feet. The least overburden is on the far west edge of the tract in Dry Fork and Corral Gulch. The maximum overburden is near the tract's northern border atop the ridge due north of core hole G-S 4-5.

3.4 HYDROLOGY

The determination of the hydrologic baseline conditions was done through studies of precipitation, springs and seeps, surface water flow, alluvial aquifers and oil shale aquifers.

A. Surface Water - Data from six gaging stations indicate a range of 9.2 to 17.4 inches of precipitation per year. The highest value was recorded at the Cathedral Bluffs station, which is at the highest elevation of the three stations. The adjusted 1975 annual precipitation for Tract C-a was approximately 10 inches.

Thirty-seven springs and seeps have been inventoried in the Tract C-a area. Some of these are intermittent, i.e., have seasonally dependent flows. More than 50% of the springs and seeps inventoried have perennial flows based on observations during the past 18 months.

All of the streams on Tract C-a can be classified as intermittent; however, some reaches are perennial. The maximum stream flow and sediment discharge in the vicinity of Tract C-a occur during snowmelt runoff as indicated by the data. While the 1974 runoff occurred during April and May, the 1975 runoff occurred during May and June. Although approximately equal, the 1975 peak runoff was slightly less than that of 1974 in the Tract C-a area as indicated by data from 11 surface water gaging stations. The snowmelt runoff leaving Tract C-a averaged about 1.5 cfs and contained about 725 mg/l of dissolved solids.

The two perennially flowing stream reaches in the vicinity of Tract C-a are the result of springs. They are: in Corral Gulch near the western tract boundary which has approximately 1/3 cfs average flow and in Box Elder Gulch. The minimum low flow coming from spring sources just west of Tract C-a is less than 0.1 cfs.

Both Corral Gulch and Box Elder Gulch generally have some flow leaving Tract C-a. Corral Gulch approximately 1/2 mile east of Tract C-a has an average annual flow of approximately 1 cfs. The mean low flow is approximately 0.4 cfs.

The important constituent to note is the dissolved solids which is an indicator of overall water quality. In the vicinity of Tract C-a, the surface water is comparably quite good, having an average dissolved solids content of about 700 mg/l. In contrast, Yellow Creek near its confluence with the White River has an average dissolved solids content of 2400 mg/l.

B. Ground Water - Three types of aquifers are present in the Piceance Creek basin. They are the alluvial, the perched and the deep bedrock aquifers. The only significant aquifers in the vicinity of Tract C-a are the alluvial and oil shale aquifers.

A total of 15 alluvial aquifer monitor holes have been completed. Eight of these holes encountered water when drilled and have had water with an average dissolved solids content of 1200 mg/l since that time. The results of the alluvial monitoring program indicate that the major drainage systems have water-saturated alluvium and that in most of the minor drainage systems the alluvium is dry. In the major drainage systems the data indicates a seasonal trend in the water levels, with rising water levels during the snowmelt runoff period and declining water levels the remainder of the year.

C. Deep Oil Shale Aquifers - The drilling programs indicated two major oil shale aquifer systems to be present under Tract C-a. The upper aquifer system occurs in the vicinity of the Mahogany zone near the top of the oil shale interval. The lower aquifer system is about 600 feet below the upper aquifer and is associated with the R-3 zone and in some cases is as deep as the Blue marker. Both aquifer systems are artesian. With the exception of the northeast corner of Tract C-a, the upper aquifer system has a higher piezometric level than the lower aquifer system. Although quite variable from place to place, the aquifers each have an average thickness of about 220 feet. Both aqufiers derive their permeability primarily from fractures and vugs.

A dual monitor hole completion was designed to isolate the aquifers in order to obtain water levels and water samples from one hole for the two different aquifers. This method of completion also allows the tubing to be removed so individual zones could be tested or pumped. Four upper aquifer pumping tests and four lower aquifer pumping tests were conducted. The effects of the upper aquifer pumping tests were observed primarily only in nearby holes. Each of the lower aquifer pumping tests generally affected all of the lower aquifer observation holes, with few exceptions.

The long-term pumping tests allowed for the calculation of transmissivity and coefficients of storage at various monitoring holes located on and around the tract. The extrapolation of these values resulted in apparent transmissivities of 2500 gpd/ft and 7000 gpd/ft for the upper and lower aquifers, respectively. The transmissivity and coefficients of storage for the lower aquifer system are considered to be much more reliable than those for the upper aquifer system.

An analysis of the various pumping tests in both aquifer systems revealed an elongation of the cone of depression along the NNW-SSE axis. A comparison of the trends of the major fracture-joint sets on Tract C-a indicate three major directions. These are generally oriented NW-SE, NNE-SSW, and N-S. The directions are given in order of decreasing number of fracture and joint orientations. Therefore, a resultant preferred directional flow in these aquifers would be along the NNW-SSE as observed during the pumping tests.

The deep aquifer monitoring program was initiated in December 1974. Early data consisted of measuring water levels. These were both static water levels and dynamic water levels as the result of the pumping program. The sampling program began in March 1975. For a period of six months, water samples were collected monthly and analyzed for the constituents as outlined by the AOSS. Both aquifers have a downward slope to the northeast. The upper aquifer has a much steeper gradient than the lower aquifer, approximately 150 feet per mile compared to 10 feet per mile. The piezometric levels intersect in the northeast corner of the tract and diverge toward the center of the basin. Thus, northeast of the tract the lower aquifer has a higher piezometric level than the upper aquifer. The upper aquifer system has been found to have better water quality than the lower aquifer system. The average dissolved solids from all monitoring holes are approximately 1150 mg/l and 1460 mg/l for the upper and lower aquifers, respectively. Tract C-a ground water quality varies, being better in the western and northwestern portion of the tract.

3.5 AIR QUALITY

Baseline air quality measurements for Tract C-a were taken at four sites from February 1975 through January 1976. Measurements were made to define the background levels prior to development of Tract C-a for comparison of these levels with prevailing and proposed Federal and state air quality standards and to aid in the interpretation and evaluation of the diffusion model results. Parameters monitored were sulfur dioxide, hydrogen sulfide, methane, total hydrocarbons, nitric oxide, total oxides of nitrogen, carbon monoxide, ozone, particulates, and particulate size. Various parameters were measured at four sites shown in Figure 2-3-7.

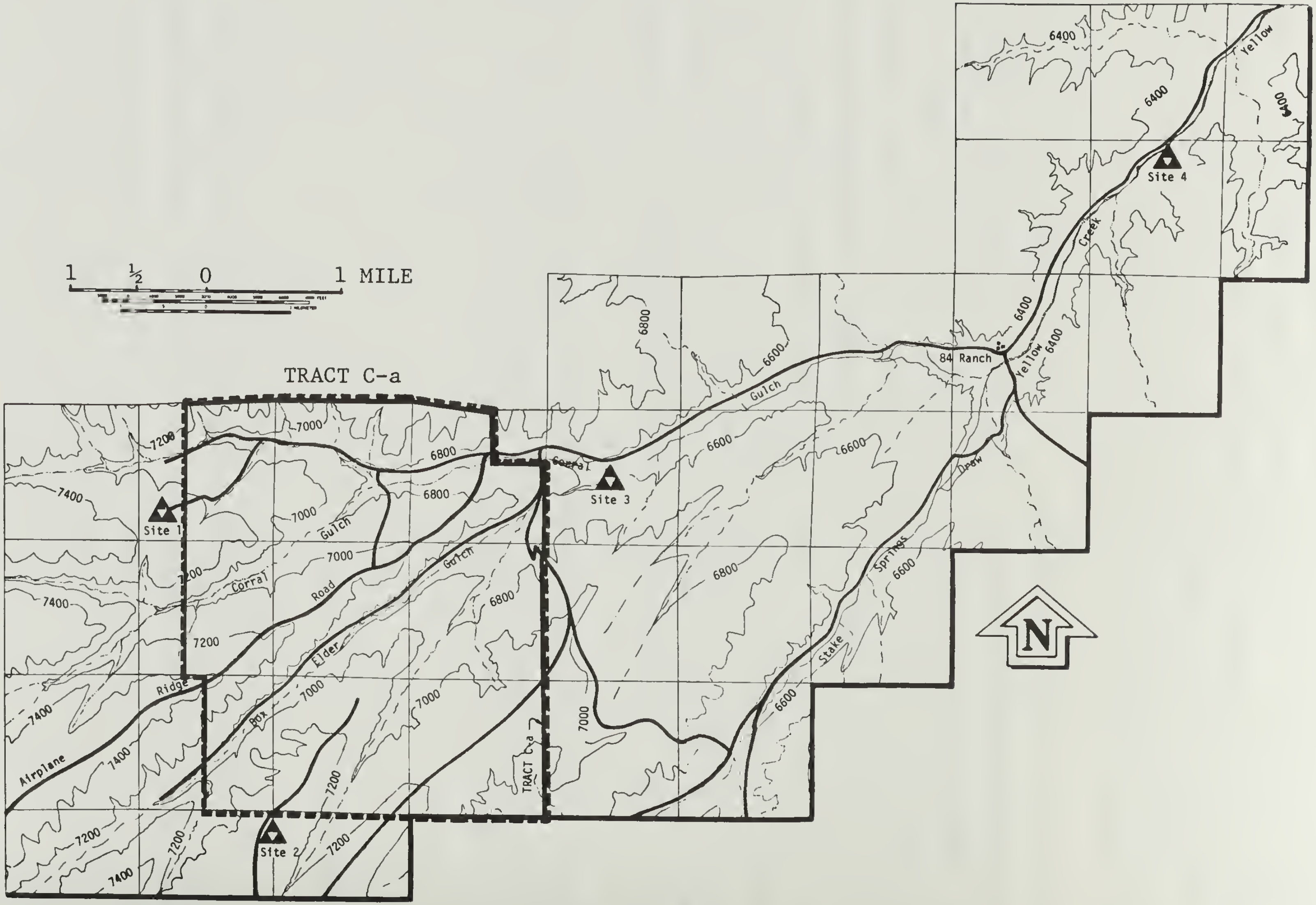


Figure 2-3-7
TOPOGRAPHIC MAP OF AREA AROUND TRACT C-a SHOWING LOCATIONS OF METEOROLOGICAL/AIR QUALITY STATIONS

The concentrations of all compounds appear to be existing background levels. The concentrations measured were low compared to the standards with the occasional exception of particulates, ozone, and hydrocarbons. Federal secondary 24-hour particulate standards were exceeded (measured values larger than maximum allowable values) five times during the year. The Federal 24-hour primary standard for particulates was exceeded once and the Colorado 24-hour standard was exceeded four times. Standards for non-methane hydrocarbons were exceeded sixty times and for ozone five times during the year, both primarily in the summer and fall.

Interrelationships between air quality and meteorological parameters were examined. Sulfur dioxide, hydrogen sulfide, and nitrogen oxides showed no significant correlation with other variables. Correlations between total hydrocarbons (THC) and wind speed were observed, THC showing a slight decrease with increased wind speed. Ozone concentrations showed correlations with insolation, delta temperature, wind speed, and relative humidity. Ozone increased as unstable conditions (increasing delta temperature, insolation, and wind speed) increased and decreased as relative humidity increased. THC, methane, and ozone also showed definite diurnal variations. Correlations between particulates and wind speed and relative humidity were found. Particulate concentrations increased with increasing wind speed and decreased with increasing relative humidity.

3.6 METEOROLOGY

Baseline meteorology studies for Tract C-a include lower and upper air studies and miscellaneous meteorological measurements. Lower air studies are designed to describe the air flow characteristics and near-surface atmospheric stability for the first several hundred feet above the surface throughout the project area. The information obtained is used to describe the existing atmospheric conditions and to provide input to diffusion models which are used for prediction of air quality impact of various project emissions and to optimize plant design to minimize the impact. Measurements were made at four locations from February 1975 through January 1976. Parameters measured include wind speed

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and direction and air temperature at all sites and temperature difference and wind sigma (stability), and relative humdity at Site 1 (Figure 2-3-7).

Measurements made at each of the monitoring sites differ due to terrain effects. These differences in location influence wind speed, wind direction, and diurnal temperature variation. Similar observations were made at Sites 1 and 2, as were also made for Sites 3 and 4. This is due to the similarity of the terrain around these groups of sites: Sites 1 and 2 are located on ridges while Sites 3 and 4 are located in gulches. Mean wind speeds at Sites 1 and 2 (10-m level) were higher than those at Sites 3 and 4(10-m level). Wind speeds at all sites averaged 4 to 7 mph higher during the daytime than at night with Sites 3 and 4 having the largest variations. Wind direction at Sites 1 and 2 are comparable and predominantly from the southwest. Wind direction at Sites 3 and 4 follow the orientation of the gulches in which they are located due to terrain-induced wind channeling effects and drainage flows. The majority of wind direction persistence occurrences observed did not exceed eight hours duration at any of the monitoring sites. Sites 3 and 4 have larger diurnal temperature variations than Sites 1 and 2; however, the mean seasonal and annual temperatures between all sites agree.

Stability was estimated by both delta temperature and wind sigma methods. Wind sigma data defined a lower frequency of occurrence of stable conditions than delta temperature data. The lack of exact correspondence lies in the classification schemes which were not designed for use in an area with topographic influences found in the Tract C-a area. Stability parameters were also correlated with wind speed and direction data. There is little correlation between wind sigma and wind speed. That between delta temperature and wind speed shows a general trend of higher wind speed being associated with more unstable conditions. Correlations of both wind sigma and delta temperature with wind direction indicate a relative minimum for westerly winds. Inversions never persisted more than 19 hours. In general, a moderately intense surface inversion formed shortly after sunset and broke up shortly after sunrise. The data show the frequency of persistence to be high up to 10 hours duration. This reflects both the length of day as well as the frequency of inversions.

Relative humidity data show that relative humidity decreased during daylight hours and that the mean relative humidity is less during the warmer months than during the colder months. Correlations with wind speed, wind direction, delta temperature and wind sigma were investigated. Relative humidity decreased with increasing wind speed up to approximately 10 mph after which there was no apparent dependency. On the average, high relative humidity was associated with northerly winds. Relative humidity was greatest when the atmosphere was isothermal, but dropped as the delta temperature increased or decreased.

Upper air studies were performed once each quarter from fall 1974 through summer 1975. These studies were to investigate the temperature and wind structure of the atmosphere (from approximately 6,300 feet to 13,000 feet above MSL) over Tract C-a for use in modeling studies to predict the environmental impact of future oil shale development of the tract. Each of the four studies consisted of ambient air temperature and wind speed and direction soundings two to four times per day for seven to fifteen days.

The gradient winds are prevailing westerlies which exist throughout the year and are interrupted by the passage of frontal systems. Local conditions within the Piceance Creek basin have a much more pronounced effect than the macroscale processes. The specific air movements produced by local conditions are often different from those expected to be caused by the major gradient flow. There is a tendency for wind velocities to be lowest about dawn, at which time there is little vertical thermal mixing and the lower surface air does not couple with the more freely moving upper air. Conversely, velocities of local winds are greatest between 1300 and 1400 hours MST when the air exhibits its greatest tendency to move vertically due to terrestrial heating, and couples with the faster air moving above it. In the absence of strong gradient winds, the terrain produces local meteorological conditions. During warm afternoons, the laterally constricted but vertically expanded air tends to blow up the valley axis. At night there is a reverse process as the colder, more dense air at high elevations flows into the terrain depressions.

Miscellaneous meteorological measurements made for Tract C-a baseline program include tracer studies, precipitation, evaporation, insolation, noise and visibility. Tracer studies were done to obtain site specific dispersion information for comparison with the diffusion model predictions. The other variables are measured to obtain baseline data and information to be used in operational planning of project activities. Initial tracer studies were biased by fugitive dust in the area. An additional study is scheduled. It is expected that information from the area specific tracer study will lower predicted concentrations. The amount of precipitation varies widely between sites. The valley sites (Sites 3 and 4) have higher amounts of precipitation than the ridge sites (Sites 1 and 2) with Site 4 usually receiving the largest amount. The amount of precipitation measured on site is lower than that measured by USGS in the project area. At this time there is no reconciliation of the difference; however, further investigation of the apparent discrepancy is being conducted. Evaporation, which is dependent on air temperature, relative humidity, wind movement, and precipitation, was highest from June through August. Insolation measurements showed the expected diurnal and seasonal variation with the highest insolation being observed between 1200 and 1500 MST and during the summer season. Background noise levels measured at all sites were low, the majority of values being below 60 dB. Visibility and visual range measurements made on site were in agreement and showed that minimum visibility exceeded 100 miles during 50% of the observation. No seasonal or monthly effects were evident.

3.7 TERRESTRIAL ECOLOGY

Terrestrial communities were analyzed with respect to species composition, abundance, habitat preference of species, species diversity and seasonal variations in composition, abundance and diversity. Important species were determined and the structure and function of local ecosystems, including species interactions and successional phenomena, identified. Included in the program were investigations for vegetation, small mammals, large mammals, mammalian predators, avifauna, reptiles and amphibians, invertebrates, and domestic livestock. An investigation of the existing condition of rangeland vegetation and its use by various types of herbivores was also initiated. Standard and accepted field laboratory analytical methods were used to develop a baseline norm against which future data, collected just prior to and after start-up of mining and retorting operations, can be quantitatively compared.

A. Vegetation - The majority of the Tract C-a study area is occupied by pinyon-juniper and sagebrush vegetation types. Elevational range of these two types overlap, with sagebrush occupying the valleys, mesas or gentle slopes with fine, deep soils and pinyon-juniper occupying ridges and steep or rough slopes having coarse, rocky or shallow soils. Competitive interactions between species increase on soil types and slopes that intergrade. The mixed brush vegetation type prevails on north-facing slopes where winter snow accumulates.

At the lower elevations of the study area, black greasewood becomes more abundant within the sagebrush type on saline alluvial soils. Shadscale occurs within this type as well as on alkaline south-facing slopes along major drainageways.

The higher elevations of the study area support the mixed brush type, characterized by the tall shrub life form of Utah serviceberry, Gambel oak and mountain mahogany. This type occupies the wetter slopes, too cool for pinyon-juniper but still too dry for aspen. Aspen and Douglas-fir types occur on the steep, generally north-facing slopes near Cathedral Bluffs, with aspen usually occupying a position of slightly lower elevation than Douglas-fir. Ridgetops approaching Cathedral Bluffs support sagebrush which integrades with the "bald" vegetation type characterized by low, drought-resistent grass and forb species in dry, wind-exposed areas.

Riparian vegetation types are rare and occur in association with small springs in open, alluvial bottomlands. Most of these, like Stake Springs, have been converted to pasturelands which are occupied by common pasture weeds. Other riparian vegetation types occur as a result of hillside springs and seeps along steep draws. Cottonwood Spring is an example which is not heavily grazed and contains a number of plant species unusual for the Piceance basin due to the paucity of riparian areas within the basin. A third type is found along drainageways of intermittent streams. These generally contain species characteristic of the bottomland sagebrush association.

Browse conditions on the study area were generally classified as good, however, a downward trend, or a decrease in condition was noted from the one year of baseline data. Further studies should allow more definitive conclusions. Mule deer use the area primarily as transitional range except in mild winters.

B. Small Mammals - Small mammals depend upon vegetation for food, shelter, and in some cases, their only supply of water. Vegetation distribution is the most important factor controlling the distribution and abundance of small mammal populations in the area.

Generally, vegetation types with the highest shrub cover (greasewood/sagebrush, rabbitbrush, and mixed brush) exhibit the greatest abundances of small mammals. The least chipmunk and deer mouse are the two most abundant species in these and many other vegetation types; they comprise over 75% of all small mammals captured in the study area thus far.

At higher elevations (about 8000 feet) fewer species of small mammals and lower abundances were observed, presumably because of the harsher environment. Two species, the red-backed vole and the red squirrel, are known to be limited to the aspen and Douglas-fir stands like those found on Cathedral Bluffs.

The greatest small mammal diversity occurs within the pinyon-juniper vegetation type. This is probably a result of the greater habitat heterogeneity. Two species, the pinon mouse and Colorado chipmunk, are found only in this type, and the bushy-tailed woodrat and golden-mantled ground squirrel exhibit an affinity for pinyon-juniper habitat.

Other small mammal species comprising only a small proportion of total abundance are the thirteen-lined ground squirrel, long-tailed vole, montane vole, and sagebrush vole. The northern pocket gopher and porcupine are also residents of the Tract C-a area as are three lagomorph species, Nuttail's cottontail, the black-tailed jackrabbit, and the white-tailed jackrabbit. Among the insectivores, the masked shrew and Merriam's shrew have been identified to date. Five bat species--the hoary bat, big brown bat, and three myotis species--have also been found in the study area.

C. Big Game - Big game species occurring in the study area are mule deer and elk. Mule deer are the most important of the two in terms of biomass, ecological interrelationships and recreational use. Relatively few elk are located in the study area and they have not been observed within the boundaries of Tract C-a during the first year of study.

Mule deer use the Tract C-a area mainly as transitional and upper winter range. They begin an influx into the area in October during their migration from higher elevations west and south of Tract C-a to winter range north and east of the tract. This movement is a gradual drift of the animals, probably in response to temperature declines and increased snow depth in their higher-elevation summer range and so movements may vary from year to year. Mule deer may use Tract C-a throughout the winter but as snow levels increase, the largest concentrations of deer are located in the pinyon-juniper and sagebrush vegetation types northeast of the tract. During late April and early May, the largest herds of mule deer characteristically occur in the meadows and bottomlands east of the tract. Movement back to the summer range takes place over an extended period. The deer meander through the area and gradually drift to the higher elevations as individuals and small groups. By late May, most of the deer in the study area occur at higher elevations west of Tract C-a.

A large amount of recreational activity is provided by these mule deer as their initial movement into the area usually coincides with the fall hunting season.

D. Mammalian Predators - The coyote, the long-tailed weasel, and the short-tailed weasel are the most abundant mammalian predators in the area. Coyote populations seem to be about average for the region based on a comparison of Federally obtained data from lines within areas of similar habitat and physiographic characteristics. Other mammalian predators documented in the study area are the bobcat and the badger. Although the mountain lion, black bear and ringtail have not been observed in the study area, they do exist in the region and may occasionally occur in the Tract C-a area.

E. Avifuana - During baseline studies, 129 avian species representing 48 families occurred in the study area. Exclusive of the raptors, waterfowl and game birds, the following species are the common year-round residents: common flicker, horned lark, Steller's jay, scrub jay, pinyon jay, blackbilled magpie, common raven, Clark's nutcracker, black-capped chickadee, mountain chickadee, plain titmouse, red-breasted nuthatch, and gray-headed junco. The relatively rare riparian habitats support the greatest bird density and diversity on an annual basis, while sagebrush and rabbitbrush support the lowest numbers of species and individuals.

Avian composition of the area varies seasonally in regard to abundances, diversity and local distributions. During summer, the largest number of birds and the greatest species diversity are encountered in a variety of vegetation types. Of the 96 species recorded in June, the most common summer residents migrating into the area were the mountain bluebird, green-tailed towhee, chipping sparrow, Brewer's sparrow, and vesper sparrow. A sparseness of birds (low diversity and abundance) is exhibited in midwinter. Among the 23 species recorded in a February census were the tree sparrow and northern shrike, both migratory species from more northerly areas. In spring and fall a composite of winter and summer populations is formed. Many areas may show the uneven pattern of distribution typical of winter, while other areas may host many birds of a considerable variety of species.

Three species of game birds occur locally. In the southwest portions of the study area, a substantial population of sage grouse exists on a year-round basis within upland sagebrush and mixed brush vegetation types. Sage grouse also occur on 84 Mesa. A relatively large population of blue grouse inhabits mixed brush and aspen/mixed brush ecotonal areas during the breeding seasons and dense stands of Douglas-fir and aspen in late fall and winter. The mourning dove is the most widely distributed gamebird in the study area during breeding and migration periods. It resides in a variety of habitats, but it most often frequents pinyon-juniper and greasewood/sagebrush vegetation types.

In the Tract C-a vicinity, a few surface ponds and intermittent streams create isolated islands of habitat for waterfowl and shorebirds. Fourteen species have been recorded using the area; primarily they were spring and fall migrants. Of these, the mallard, green-winged teal, blue-winged teal, killdeer, and common snipe were the most common.

Fourteen diurnal and four nocturnal raptors are known to use the Tract C-a area. The red-tailed hawk was frequently observed during all times of the year except late winter. The rough-legged hawk, a species which breeds in arctic tundra, was the most common wintering raptor. Golden eagles occurred throughout the year with the largest number observed during winter. The marsh hawk and American kestrel were common nestors during summer, but only a few individuals were recorded during the winter. The common raven was the most prevalent raptor-like species in all vegetation types. Other diurnal raptors included the turkey vulture, goshawk, sharp-shinned hawk, Cooper's hawk, Swainson's hawk, bald eagle, prairie falcon, merlin, and peregrine falcon. Nocturnal species included the great horned owl (most common), pygmy owl, short-eared owl, and screech owl. Thirty-one active raptor nest sites were located in the study area.

F. Reptiles and Amphibians - Five reptile species are known to occur in the study area, of which the sagebrush lizard is the most abundant. The others are the eastern fence lizard, tree lizard, short-horned lizard (horned toad), and western terrestrial garter snake. Greatest abundances of lizards were observed in the pinyon-juniper vegetation type where there is adequate open ground for sunning, as well as bushes, deadfalls, and occasionally rocky outcrops providing refuge.

Three amphibian species--the chorus frog, Great Basin spadefoot, and tiger salamander--were documented as occurring in the study area at two breeding ponds. The area has very few habitats suitable to breeding populations of amphibians, and abundances and species diversity is low where they do occur.

G. Invertebrates - Invertebrate numerical abundance over the summer was greatest in the greasewood/sagebrush habitat where the active flying insects were very abundant relative to those in other vegetation types. They account for much of the difference in invertebrate numerical abundance between this and the other vegetation types sampled. The sagebrush type contributed the second largest overall invertebrate numbers; however, ground dwellers were the most commonly encountered group in this vegetation type. The majority of invertebrates captured on the ground or in the litter were springtails, mites and ants.

The mixed brush vegetation type also contained relatively large numbers of invertebrates, occurring primarily in the herbaceous stratum. In the pinyon-juniper vegetation type, ground dwelling and actively flying invertebrates were relatively abundant; however, invertebrate numerical abundance from the tree, shrub, and herbaceous strata relative to that of other vegetation types was low.

Of the shrub sampled, shadscale had the lowest number and variety of associated herbivorous invertebrates. By contrast, the greatest number and variety of herbivorous invertebrates found on sampled shrub species were taken from rabbitbrush and sagebrush in the greasewood/sagebrush vegetation type.

Seasonal trends from sampling efforts in all habitats indicate that peaks in population numbers and variety of species groups occurred in July. The one exception was the active flying insect group which was at its largest numerical abundance in June.

Major orders of ground dwelling invertebrates in all vegetation types throughout the season were springtails and mites. Of the active flying insects, the numerically dominant taxa found in all vegetation types sampled were two fly families, non-biting midges and anthomyiid flies. Each shrub, tree, and herbaceous species sampled has a complement of herbivore species, primarily from the order Homoptera. Ants were the numerically dominant family found in all strata when all vegetation types sampled are considered.

H. Feral Horses - Horses use portions of the study area throughout the year and are most frequently observed west of Tract C-a, although herds also occur on both 84 Mesa and Wolf Ridge. The largest herd of horses in the study area is frequently seen on the southwestern edge of Wolf Ridge. Horses have been noted several times immediately adjacent to the tract but have seldom been recorded within the tract boundaries. This distributional pattern is probably associated with human disturbance factors in conjunction with pre-development activities. Fences may also restrict movements over certain portions of the study area.

I. Domestic Livestock - Cattle distribution and dispersal in the are are dictated mainly by herding and climate. Cattle are moved to higher elevational ranges in the spring as the snowpack recedes and vegetation becomes green. In the fall, inclement weather conditions force the cattle to return to lower-elevation rangelands.

J. Threatened and Endangered Species - Federal and state wildlife agencies and the Smithsonian Institution have compiled lists of plant and animal species which are "threatened", "rare", or "endangered". In determining the status of a species, the entire range of the species is considered. By Federal standards, an "endangered" species is in danger of extinction throughout all, or a significant portion, of its range; a "threatened" species is likely to become endangered within the foreseeable future throughout all, or a significant portion of its range; and a "rare" species exists as a small population within its range.

Habitats of rare plants are often associated with young unstable geologic conditions such as talus slopes, mountain tops, rock cliffs, or shale barrens. One endangered plant species, a milkvetch, was found growing on shale outcroppings northwest of Tract C-a. The rare milkvetch is known only to occur on dry, calcareous shales at lower elevations in the drainages of the White River, Rio Blanco County, Colorado, and adjacent areas of Utah.

The peregrine falcon is considered an endangered species by the United States Department of the Interior (1975). It has been observed four times in the Tract C-a study area since October 1974. Two of the observations were within the tract boundaries. It is impossible to determine how many individuals (from one to four) the four sightings represent because of the high mobility of this raptor. It is unlikely that peregrine falcons nest in the study area due to the lack of large cliff faces and the paucity of water.

The Colorado nesting population of the greater sandhill crane is considered endangered by the Colorado Wildlife Commission (1973). Approximately 30 greater sandhill cranes were recorded in the study area. Based on observations made during spring and fall surveys, 84 Mesa and its environs may serve as a staging and foraging area for cranes during their spring and fall migrations. Extensive surveys were conducted to determine if these cranes were nesting along the White River but none were sighted.

3.8 AQUATIC ECOLOGY

The overall objectives of the aquatic baseline studies are to characterize existing aquatic communities on and in the vicinity of Tract C-a and to inventory aquatic habitats that may be affected by RBOSP development. The aquatic investigations include water flow, water chemistry, plankton, periphyton, benthos, macrophytes, fish, and springs and seeps. The location of aquatic sampling stations are shown on Figure 2-3-8.

Periphyton is the major source of autochthonous primary production in waters of the study area. Periphyton standing crops were usually greatest in the White River and lowest in the waters of the headwater and tract areas. In the alkaline spring-brook habitats of the headwater and tract areas; diatoms comprised the dominant algal group in the periphyton. The most abundant taxa included Achnanthes minutissima and Navicula Cryptocephala. Shannon diversity indices for periphyton were lowest in the headwater and tract regions, suggesting that the periphyton communities in these regions were less complex than those in the most permanent streams of the region. In Yellow Creek, diatoms generally dominated the periphyton but filamentous algae, including Chara kieneri and several blue-green species, were also frequently abundant. Periphyton diversities in Yellow Creek were intermediate between those of the tract and headwater areas (lower diversity) and those of the White River (higher diversity). In the White River, the diatoms were again the dominant taxa in the periphyton. Periphyton standing crops and species diversities were higher in the White River than in any other of the study areas. The most abundant alga in the White River periphyton was the diatom Epithemia sorex.

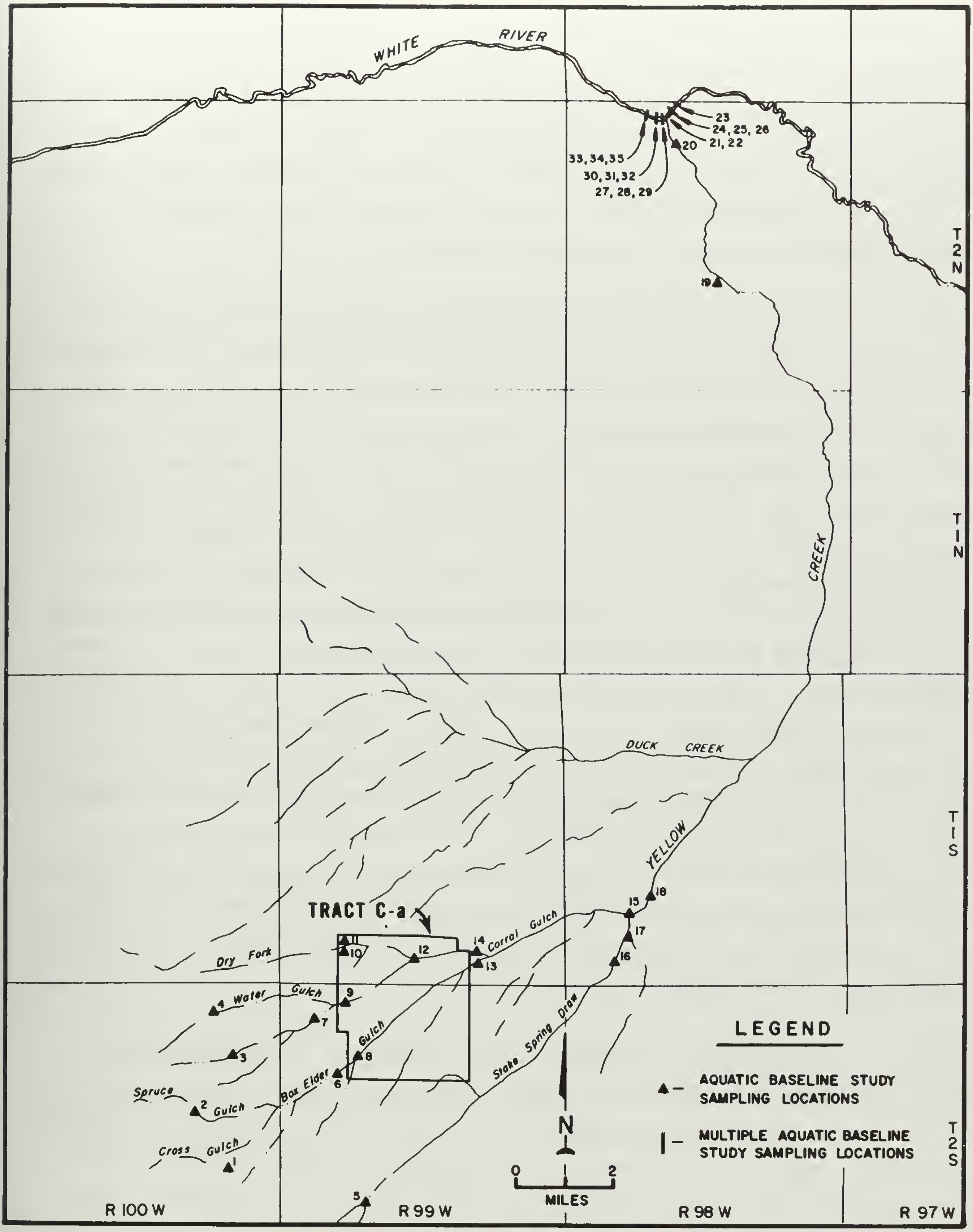


Figure 2-3-8

RBOSP AQUATIC SAMPLING LOCATIONS

In all study areas, the phytoplankton were usually a secondary source of primary production and in most areas the phytoplankton species composition and abundance indicated that phytoplankton was primarily recruited from the periphyton. Diatoms generally dominated the phytoplankton in all areas. Different phytoplankton species were dominant in each of the three general areas of study (i.e., tract and headwaters, Yellow Creek and the White River), and phytoplankton abundance was generally low in all areas.

The zooplankton fauna in the spring-brook habitats of the headwater and tract areas consisted primarily of species associated with a substrate. The dominant Crustacea in these spring-brooks included the cyclopois *Eucyclops agilis* and the harpacticoid *Bryocamptus hiemalis*. The peak densities and number of species of both rotifers and cladocerans occurred during the summer months. The zooplankton fauna of the marshy pond area (Station 5) on Stake Springs Draw was generally similar to that of Yellow Creek. At the pond (Station 14) on Corral Gulch, the dominant taxa included rotifers and Crustaceans. At that pond the dominant fauna included *Ceriodaphnia quadrangula*, bdelloids, *Monostyla*, *Lepadella*, *Euchlanis* and other monogononts. The zooplankton fauna of the pond area (Station 19) of lower Yellow Creek differed from other areas of study in that portion of Yellow Creek. The rotifer fauna of Yellow creek included *Notholca acuminata*, *Notholca squamula*, and *Colurella adriatica*. The most abundant Cladocera of Yellow Creek were typically summer species and included *Pleuroxus aduncus* and *Alona circumfibriata*. The paucity of lakes, ponds, pools, and backwater areas in the White River near the study area accounts for the low abundance of planktonic rotifers and limnetic Crustacea in the White River. The cladocera of the White River included *Alona*, *Pleuroxus* and *Chydorus*, but abundance of these organisms was also low.

The benthic fauna of the spring-brooks of the headwaters was dominated by Oligochaeta belonging to the Naididae and Enchytraeida and by aquatic insects, particularly the Chironomidae and Simuliidae. The benthic fauna of the spring-brooks of the tract area included taxa with short life cycles and taxa which can easily invade new waters. Whereas the densities of certain benthic taxa remained high in the tract region, the number of species and the species diversity and richness were lower than those in the headwaters. The intermittent nature of many of the waters on and near the tract limits the fauna which can exist there and thus limits diversity. As in the headwaters, the aquatic insects and Oligochaeta dominated the benthic fauna of the spring-brooks on and near the tract. In the marshy-pond habitat at Station 5 (headwater area) where sedges, watercress and other vegetation were abundant, the most abundant benthic taxa belonged to the Tubificidae, Chironomidae, Ephemeroptera, Simuliidae, and Oligochaeta. In the single pond habitat (Section 14) of the tract area, the benthic community included Ephemeroptera, Corixidae, Dytiscidae, Chironomidae, Ceratopogonidae, Anthomyiidae, and Oligochaeta. In Yellow Creek, the diversity of the benthic fauna was limited by the harsh chemical conditions which occurred there. Those species which tolerate the harsh conditions, particularly the Simuliidae and Chironomidae, occurred in great abundance. The dominant benthic organisms in Yellow Creek were aquatic insects and Oligochaeta. In the pond area (Station 19) of Yellow Creek, the number of species and the species richness were generally higher than in any other area of the creek. The rubble substrate of the White River provides many interstitial spaces as available habitat for benthic organisms. The benthic diversity in the White River was higher than in any of the other areas studied, but the density of benthic macroinvertebrates was lower than that of Yellow Creek. The most diverse species occurring in the White River were Ephemeroptera, Trichoptera, and Plecoptera; the most abundant benthic macroinvertebrates were the Ephemeroptera, Diptera, and Oligochaeta.

Studies of the fishes of Yellow Creek and the White River indicated that the occurrence of fish in Yellow Creek is restricted by harsh physical and chemical conditions. The most abundant fish species observed in the White River study area were rough and forage species. They included flannelmouth sucker, bluehead sucker, speckled dace, fathead minnow, and mottled sculpin. Trout are rare in the study area, a fact at least partly due to the higher than optimum water temperatures which occur periodically and to the high concentrations of suspended solids which are deleterious to trout eggs.

The fish recorded in the RBOSP study area occurred primarily in the White River. Physical characteristics such as rapid temperature fluctuation and low discharge restricted fish occurrence in Yellow Creek.

The fish community of the White River is dominated by members of the minnow, sucker, and sculpin families (e.g., flannelmouth sucker, bluehead sucker, speckled dace, fathead minnow, and mottled sculpin). With the exception of the fathead minnow, they are native species, and all are well adapted to the swift, turbid, "cool water" environment.

Game fish such as trout and mountain white fish are rare in the study area. The reason for this is a combination of factors including periodic elevated summer water temperatures, insufficient shelter, and high silt loads. The latter is probably the most important factor because of the deleterious effect of silt on trout eggs. Those areas of the White River in the study area that might otherwise be suitable for trout spawning have deep silt loads. Consequently, no significant fishing occurs in this stretch of the White River. A minimal amount of angling for channel catfish apparently is carried out by a few local residents.

3.9 SEISMICITY

A seismicity investigation of the Piceance Creek basin has shown that the seismicity of Tract C-a is low. It was shown that the basin is classified as Zone I where structures in this zone built to withstand fundamental periods greater than 1.0 second can be expected to suffer no more than minor damage from large distant earthquakes. Maps of seismic activity in Colorado show that the only earthquakes of magnitude 2 or greater in Colorado within 40 miles of the tract were at Rangely (postulated to result from the water flooding of the Rangely oil field) and Harvey Gap Reservoir (believed due to the effect of the loading by the stored water). A search of the National Oceanic and Atmospheric Adminsitration historical seismic data in an area within 50 and 100 miles of Tract C-a (for the period 1941 to 1975) confirmed these findings.

A seismic station in connection with a nuclear gas stimulation project recorded only two micro-earthquakes (local magnitude less than 1) for a two-year period in the vicinity of the tract. This was in close agreement with a USGS seismic investigation of the Rangely oil field. Seismic data for a seven-year period showed no more than one earthquake of local magnitude greater than one.

Strain release data of the United States indicate little probability of any strain stored in the subsurface in the Tract C-a area to cause earthquakes.

3.10 ARCHAEOLOGY

An extensive archaeological surface survey was conducted on and in the vicinity of Tract C-a to gather information on the presence or absence of archaeologically important materials. Materials located in the study area were subjected to laboratory analysis in an effort to establish their cultural origin, the extent and length of occupation they represent, cultural advancement of peoples who used or manufactured them, and the migratory patterns of the human users. Information gained through laboratory and field analyses were then compared to data available from the literature.

After assimilation of the information discussed above, judgements were made regarding the importance of specific sites relative to all material found in the area, and the importance of the entire area was defined in terms of its contribution to the science of archaeology. Material is now being analyzed to determine if any sites should be nominated to the National Register of Historic Places.

A total of 197 separate sites yielded archaeological material of some kind. The materials collected from these sites ranged from a few fragments of toolstone to the remains of wickiup structures.

Each one of these sites was classified into one of three classes on the basis of number or significance of artifacts, or areal extent represented by the location. The most important sites (those yielding the largest number of or most important artifacts) relative to the study were defined as primary sites. Those second in importance were identifed as secondary sites, and those of least importance were classed as tertiary sites.

Only 22 of the 197 sites were defined as primary sites. Thirty-three were described as secondary sites and 142 were classified as tertiary sites.

Twenty-two sites (20 tertiary and 2 secondary) were located on Tract C-a, however, four of these sites were in close proximity to areas reported as important in the literature. Their status is currently under further investigation. Sixty-one sites (11 primary, 9 secondary, 41 tertiary) were found on 84 Mesa. The site classifications given above were made relative to other locations in the study area. They do not reflect the significance of the study area relative to other regions. When discussed in view of its overall archaeological importance, the study area is not considered a "rich" archaeological find. Its importance lies in the fact that, prior to the current study, few archaeological studies had been conducted in the area.

3.11 PALEONTOLOGY

No significant paleontologic finds have been observed on the surface in or around Tract C-a. Geologists involved in the surface geologic mapping program encountered only small plant remains, mainly fragmental, scattered throughout the outcrops of the upper Parachute Creek Member, Green River Formation. Remains of this type are relatively common throughout the Piceance Creek basin. No fossils were observed in the overlying Uinta Formation.

In the subsurface, a review of tract core hole lithologic description logs disclosed the presence of sparse small fish remains below the Blue marker in the Garden Gulch Member in three G-S core holes. No other vertebrates were observed in the subsurface. These fish remains are also not unique to Tract C-a. A literature search located fish remains at the "pipeline" outcrop section on Cathedral Bluffs about five miles southwest of Tract C-a and reported their presence in the Parachute Creek and Garden Gulch Members in both the Piceance Creek and Unita basins of Colorado and Utah, respectively. Also reported at the "pipeline" section are turtle and insect remains and a catfish skull in oil shales above the Mahogany zone. None of these fossils have been found within or in the immediate vicinity of Tract C-a.

3.12 SOILS

An inventory of soil types found on Tract C-a and adjacent areas, their physical and chemical characteristics, and distribution is being made for use in ecological analyses, engineering, and revegetation studies.

A preliminary soils and vegetation survey of Tract C-a, 84 Mesa, and adjacent areas was conducted in Spring 1975. Data from the survey were used to produce a preliminary map of soil series distribution on Tract C-a and adjacent areas. Eleven soil types and one rock outcrop have been identified.

Soil types found on Tract C-a and the surrounding area include:

- Aridic Haploboroll
- Forelle
- Glendive
- Hagga
- Hanly
- Havre
- Lithic Haploboroll
- Piceance
- Redcreek
- Rentsac
- Yamac
- Rock Outcrop - Torriorthents

Additional information on the distribution of the various soil types, depths, zonation, number and width of horizons, and physical and chemical characteristics is being prepared and correlated with the type and success of vegetation in the area.

A soil chemistry and physical study is being conducted to determine major and minor chemical elements, erosion potential, and moisture-holding capacity in surface soils of Tract C-a and surrounding areas. The potential of soils as a source of nutritive elements as well as possible toxic elements is being studied. Soil chemistry data will be correlated with phytosociological data and plant distribution to ascertain relationships between plant response and soil chemical characteristics. Determination of erosion potential and moisture-holding capacity of soils will be made to aid in identifying soils that may be used for revegetation. Samples are currently being analyzed and reports will be submitted upon completion of the program.

Several characteristics of subsurface soil and overburden are being determined for Tract C-a and surrounding areas. Physical and structural testing is being used to evaluate use potential of soil and overburden for plant structures, disposal and storage sites, and reservoir construction. Chemical analyses are being conducted to identify potentially toxic materials that may limit rehabilitation efforts and/or contribute potentially toxic materials (especially trace metals) to surface and ground water systems. Quantity and depth of the overburden soil are being used to determine soil availability for rehabilitation. Field work and laboratory analysis are currently underway.

3.13 TRACE METALS

An investigation is being conducted to determine the presence or absence of toxic trace metals in the soil in the Tract C-a study area. This program is being conducted jointly with the soil chemical program (3.12) with field work and laboratory analysis currently underway. This information, in conjunction with soil data (e.g., texture, soil moisture release curves) and available literature, will determine if plants (terrestrial and/or aquatic) should be sampled for trace metals. If it is necessary to sample certain species of plants, then, following data analysis and interpretation, another judgement will be made as to whether or not sampling of first order herbivores (e.g., deer, long-tailed voles, etc.) should be conducted. Based on the results of the tests, this process could continue up to the highest order, the carnivore.

3.14 ECOLOGICAL INTERACTIONS

A description of ecological interactions provides a concise synthesis of baseline environmental data and a holistic description of terrestrial and aquatic ecosystems.

Ecological interactions encompass all the interactions between living organisms and their environment. Since the environment includes all physical, chemical, and biological factors to which an organism is subjected, the range of interactions, even within a small system, can be widespread and complex, and in some cases, extremely subtle. The lack of adequate technology, in combination with the complexity of the problem, make it impossible to discuss all the interactions which affect a given ecosystem.

The definition of an ecosystem can vary in respect to the magnitude, duration and production of the entity being described. The entire globe can be considered an ecosystem as can an island, a forest, a pasture, a decaying tree stump, or even a temporary pool. In the case of Tract C-a, the boundaries of the ecosystem studied were arbitrarily established to coincide with the boundaries of the tract and a five-mile perimeter. These boundaries encompass seven distinct vegetation communities and four types of aquatic habitat. Ecological interactions on Tract C-a are summarized in Figure 2-3-9 which depicts the flow of energy and nutrients throughout a typical ecosystem.

Within the Tract C-a study area, sagebrush, pinyon-juniper, and mixed brush communities can be defined but, in each case, transition zones between each type can also be identified. These transition zones represent overlapping environmental conditions which favor neither community but can sustain mixtures of both. Frequently these transition zones produce greater ecological diversity (and interactions) than do "pure" communities.

In the more shallow arid soils of the surrounding ridge tops, pinyon-juniper is the dominant vegetation type. Although there is distinct zonation between sagebrush and pinyon-juniper in some cases, the typical case is a gradual transition where soil depth does not vary sharply. In these areas, big sagebrush is often a component of the pinyon-juniper understory; however, as the

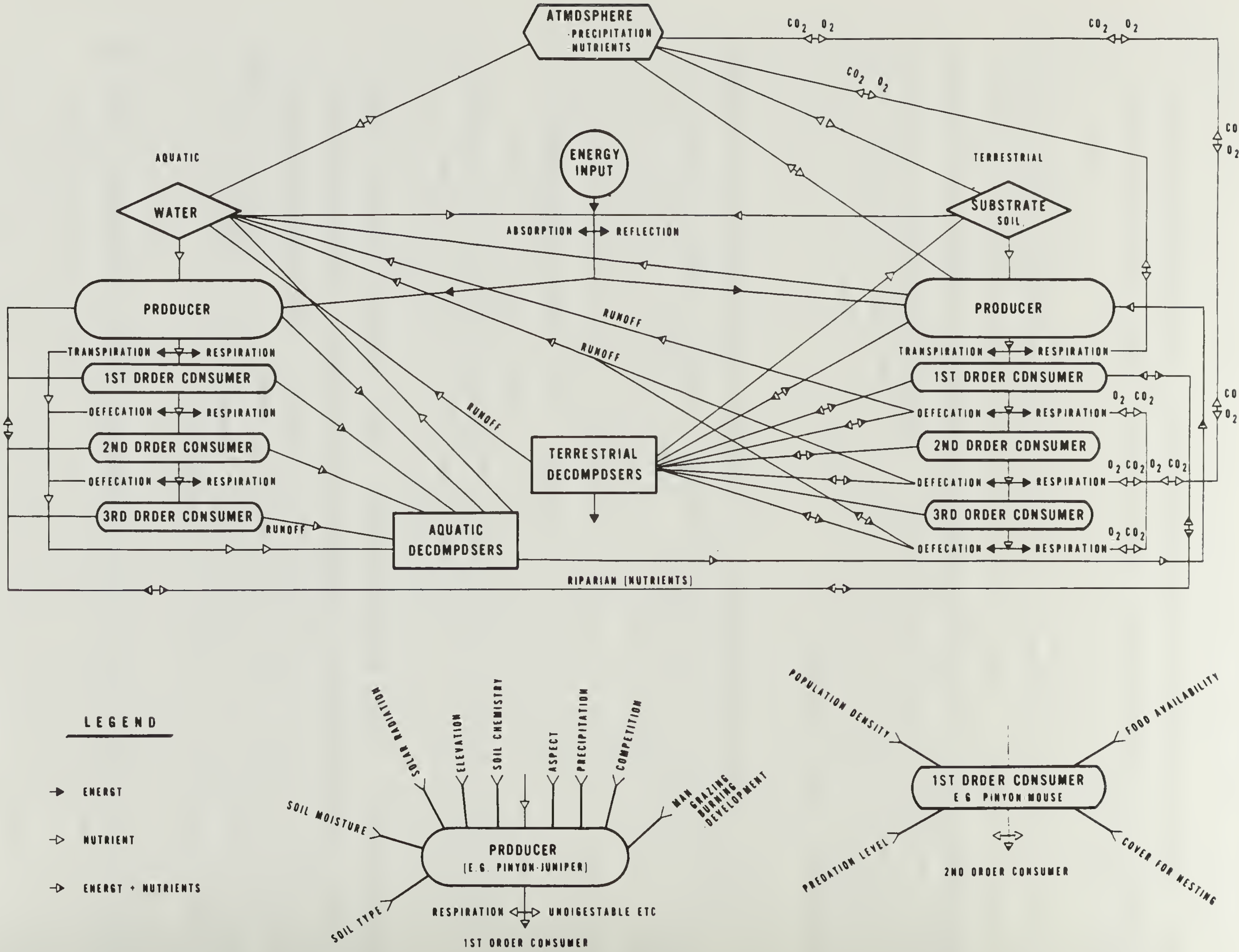


Figure 2-3-9

ECOLOGICAL INTERACTIONS ON TRACT C-a

canopy thickens and litter accumulates, big sagebrush often disappears in the pinyon-juniper understory. Where the pinyon-juniper community has been subjected to fire, grasses and herbaceous species have invaded the area and, in later stages, have been followed by sagebrush and/or rabbitbrush, depending on the elevation and alkalinity of the soils.

Ultimately, pinyon-juniper may re-establish itself in burned-over areas. If grazing is heavy during early stages of revegetation in burned-over areas, pinyon-juniper may be prevented from reinvading the area because of the destruction of young shoots.

In the higher elevations reaches of the study area, sagebrush and mixed brush communities intermix. Both communities thrive in deep soils (mollisols); however, mixed brush (especially Gambel oak) requires more soil moisture than sagebrush. Despite their common soil requirements, there are few distinct transition zones between these two communities in the study area. In fact, one of the upland sagebrush associations supports Utah serviceberry and mountain snowberry in its shrub stratum. This association ranges from the fairly smooth terrain of 84 Mesa to steep slopes below the summit of Cathedral Bluffs west of Tract C-a. These high elevational sagebrush-mixed brush communities provide a patchwork effect when viewed from the air.

Intergrading of pinyon-juniper and mixed brush appears to be closely related to soil type and elevation. Pinyon-juniper is found on shallow, arid soils and on shale outcroppings where soil moisture is limited, whereas mixed brush requires deeper soils and increased moisture availability. In addition, pinyon-juniper elevation range is between 1,850 to 2,300 m as opposed to mixed brush, which is more restricted in elevation (2,150 to 2,485 m). The increase in precipitation with elevation primarily accounts for the distribution of these communities.

Productivity of the three major terrestrial community types ranges from 105 kg/ha in pinyon-juniper communities to 271 kg/ha for mixed brush, with sagebrush averaging 210 kg/ha. Browse utilization in these areas ranges from 7% on sagebrush sites, 24% on pinyon-juniper sites, to 44% on mixed brush. Low productivity is associated with heavy use in the mixed brush and pinyon-juniper community. Heavy grazing causes constant shifts in animal species composition and abundance in these communities. Eventually this affects other communities as well. Reduction of the herbaceous vegetation due to heavy grazing, fire, or other factors will result in a change in plant species composition, followed by a change in animal species distribution and abundance. Reduction of the herbaceous layer could also affect the character of the soil substrate and influence erosion potential. This is important to adjacent aquatic communities because the stream valley interacts with the stream in every respect. The geologic strata of a region determines availability of ions, soil characteristics, and topography. Soil and climate determine vegetation, and vegetation controls the supply of organic matter. Organic matter reacts with soil to control the release of ions. Compounds, particularly nitrogens and carbons, control decomposer organisms and decay of litter and, hence, lie right at the foot of the food cycle. The dynamics of the aquatic system are related to this complex set of interactions between climate, soils, topography, and terrestrial plant and animal communities.

Although dynamics of the aquatic system are largely controlled by its entire valley, interactive feedback from the stream to the terrestrial system also occurs. On the microscale, both the stream and the terrestrial system are astoundingly complex sets of ecosystem interactions. However, the interactions can be generalized with a good degree of confidence from basic ecological principles.

CHAPTER 4
MINING

Open pit oil shale mining on Tract C-a will be comparable to open pit mining of iron and copper as practiced throughout the world. Conventional drilling, blasting, loading and hauling equipment will be used during both Phase I and II operations.

The mining plan described covers a period of 38 years, beginning in 1977 with construction of support facilities, a pit dewatering system, haul roads, and primary crushing equipment. Assembly of primary mining equipment will begin in early 1978, and preproduction overburden removal will begin in mid-1978. Ore production is scheduled to begin in mid-1979. During the six years of Phase I operations, ore production will average about 4.6 million tons annually, peaking at about 6.8 million tons in 1984.

Phase I mining operations will expose enough oil shale so that increased overburden removal for Phase II operations need not begin until only two months before startup of the Phase II processing facility. Ore production to satisfy Phase II requirements will begin in mid-1985, then gradually increase during the following two years until a constant rate of about 39.3 million tons annually is reached in 1987.

Table 2-4-1 is a yearly summary of the production of sub-ore, overburden and waste, and ore. Overburden is defined as all material removed between the ground surface and the top of the uppermost ore zone encountered in mining. Sub-ore is low-grade oil shale having a Fischer assay oil content ranging from eight gallons per ton (GPT) to a selected cutoff grade higher than eight GPT. Waste is low-grade oil shale having an oil content of less than eight GPT.

Mining will begin in the extreme northwest corner of Tract C-a and expand to the east and southeast. At the end of the 38-year period described in the

Table 2-4-1

MINE PRODUCTION SCHEDULE
million tons

Year	Sub-Ore	Overburden & Waste	Ore	Total
1978	2.0	3.5	-	5.5
1979	3.1	6.3	1.0	10.4
1980	2.1	6.8	2.4	11.4
1981	3.0	5.3	3.2	11.5
1982	2.0	5.0	4.5	11.5
1983	1.1	4.4	6.0	11.5
1984	0.8	1.9	6.8	9.5
1985	3.2	13.8	16.3	33.3
1986	6.4	29.9	33.3	69.6
1987-1989	7.5	34.8	39.3	81.6
1990	6.1	33.4	39.3	78.8
1991-1994	5.1	32.4	39.3	76.8
1995	4.4	25.4	39.3	69.1
1996-2014	3.9	20.4	39.3	63.6
2015	1.7	8.6	22.3	32.6

DDP, the mine will occupy about 750 acres. In effect, Phase I mining operations will not differ dramatically from Phase II operations except in size, the location of primary crushing, and the method by which overburden, waste and sub-ore will be conveyed to disposal: these materials will be hauled by truck during Phase I and by belt conveyors during Phase II. Open pit mining on Tract C-a will typically consist of six distinct steps:

- Drilling
- Blasting
- Loading
- Hauling to primary crushing
- Primary crushing
- Conveying to disposal or processing

Blasthole drilling will be accomplished with rotary blast hole drills capable of sinking 15-inch diameter holes. Blastholes will be charged with a mixture of ammonium nitrate and fuel oil (ANFO) and detonation initiated by electric blasting caps via suitable primers. Either secondary drilling and blasting or a hydraulic rock breaker will be employed to reduce the size of oversize rocks, if necessary.

Electric power shovels (probably in the 11-cubic yard class with 13-cubic yard dippers) will be used during Phase I for loading mine rock into trucks for transport to primary crushing; 25-cubic yard shovels with 30-cubic yard dippers will be used in Phase II. The power shovels will be supplemented by 15-cubic yard front-end loaders. Rubber-tired bulldozers will also be used in the pit for clean-up and other maintenance work.

During Phase I, 85-ton diesel-powered dump trucks will be used for transporting ore from the mine face to primary crushing and for hauling overburden, waste and sub-ore to disposal. As now planned, a fleet of 170-ton diesel-electric dump trucks will be used for hauling ore to primary crushing during Phase II.

Primary crushing equipment will be located outside the pit during Phase I and in the pit during Phase II. A large, single-rotor impact crusher will be used in Phase I while three 72-inch gyratory crushers (one each for ore, sub-ore, and overburden and waste) will be used in Phase II. Only ore will be crushed during Phase I.

Crushed ore will be transported to storage near the processing facility by belt conveyor during both Phase I and II for further size reduction before being fed to retorts. A 42-inch belt conveyor will be used in Phase I; a 60-inch belt conveyor will be used in Phase II. Sixty-inch belt conveyors will also be used in Phase II for transporting sub-ore and overburden and waste to disposal.

Mine design parameters are as follow:

- Final slopes of approximately 45°
- Operating bench heights of 50 feet and bench cut widths of 230 feet
- Operating safety benches of 50 feet for every 50 feet of height
- Final safety benches of 50 feet for every 100 feet of height
- Minimum operating bottom width of 500 feet

Figure 2-4-1 is a geologic structure map of Tract C-a which shows the approximate outlines of the Phase I and Phase II open pits. Figure 2-4-2 is a north to south cross section of the planned final Phase I open pit showing the overburden and depths to various oil shale zones in the pit area. Oil shale beds generally dip about 4° basinward to the east and east-northeast. Two minor parallel and vertical step faults trend southeastward through the area with surface displacements of only 5 feet and 10 feet. These two minor faults are not considered detrimental to pit slope stability.

Surface joints measured in the Phase I area indicate the presence of a joint system consisting of three sets of joints. The joint surfaces are generally spaced 10 feet or more apart but locally average less than 1 foot apart. Pit slope stability will not be directly affected by the joint sets because of the high angle of dip of these joints; however, where the joints intersect locally tilted bedding planes to form wedges, local bench failures may occur.

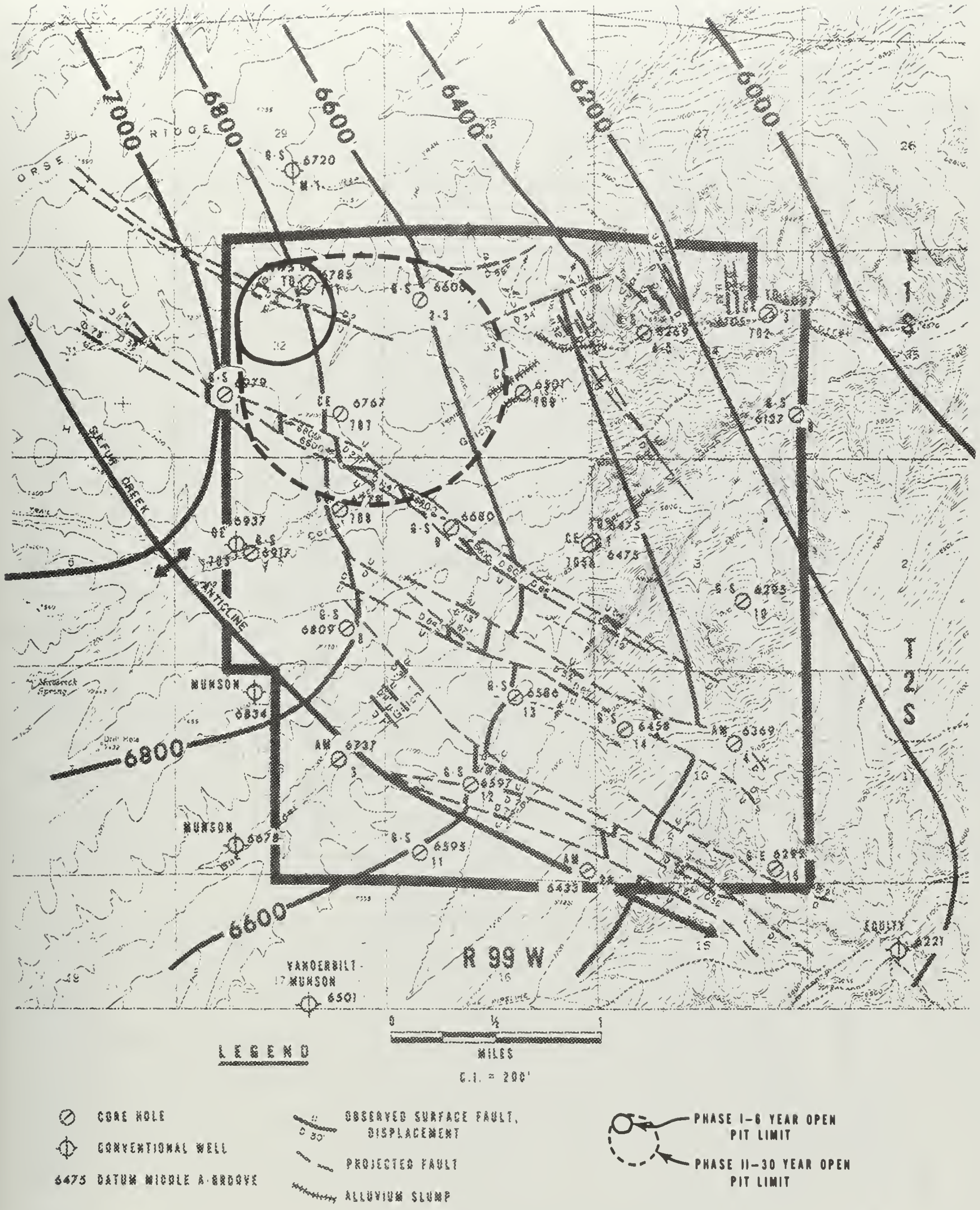
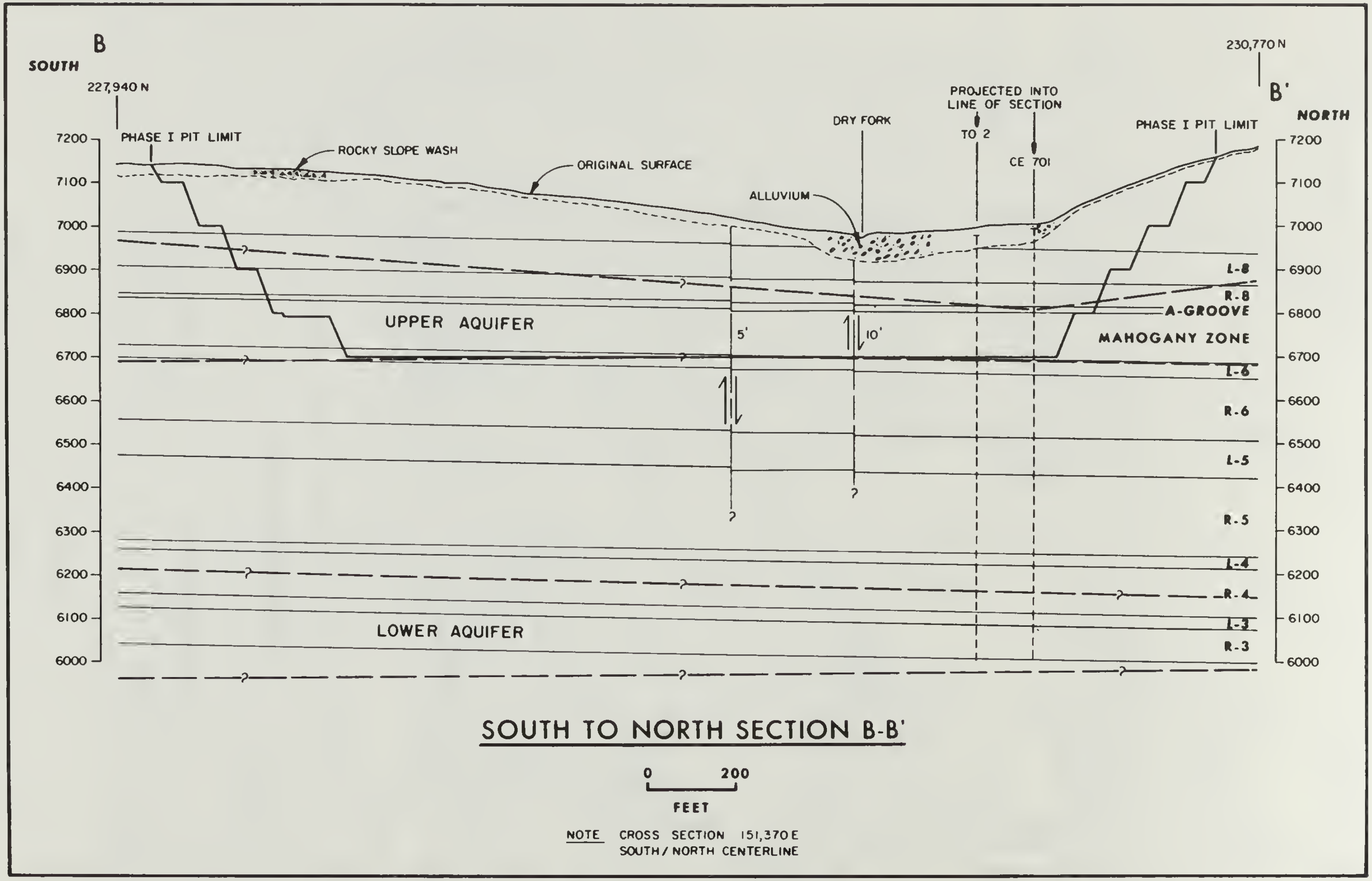


Figure 2-4-1

TRACT C-a MIDDLE A-GROOVE STRUCTURE MAP SHOWING LOCATIONS OF PHASE I AND PHASE II OPEN PITS



SOUTH TO NORTH SECTION B-B'

NOTE CROSS SECTION 151,370 E
SOUTH / NORTH CENTERLINE

Figure 2-4-2

PHASE I MINE GEOLOGIC CROSS SECTION

The Phase I open pit mine will intersect the upper aquifer as shown on Figure 2-4-2. The upper aquifer will have to be dewatered in the vicinity of the Phase I mine. Water produced during Phase I mining will have a dissolved solids content of approximately 1,000 mg/l. Boron and fluoride concentrations will probably average about 0.7 mg/l and 3 mg/l respectively. All water produced during Phase I dewatering will be used in retorting and related activities.

Figure 2-4-3 is a cross section of the open pit after 30 years at the Phase II production rate. Oil shale beds in the Phase II area continue to dip basinward at about 4°, similar to the Phase I pit area. Major faulting will be encountered in the south and southwest portion of the Phase II open pit where the northernmost northwest-trending graben is located. Faults associated with this graben are vertical to near vertical and stability analyses of pit slopes cutting through this graben indicate that a 45° pit slope should be stable. Mining to the east and northeast portion during Phase II will encounter additional faulting and minor folding. Massive failure of the pit slope is not expected to occur in this area but local failures along working benches are possible.

Joint sets in the Phase II pit area are similar to those in Phase I except that in the eastern portion of the area a fourth set of joints with a shallow angle of dip exists. This fourth set of joints may cause some local pit failure. The R-3 zone may cause some pit slope stability problems because this zone is characteristically vuggy and overall rock strength is probably greatly reduced.

The 30-year Phase II mine shown on Figure 2-4-3 would intersect both the upper and lower aquifers. The water quality of the upper aquifer would be approximately the same as that for the Phase I mine. The lower aquifer would have to be dewatered during Phase II mining. Baseline data indicate that lower aquifer water quality averages approximately 1,200 mg/l dissolved solids. Boron and fluoride concentrations are found to be higher in the lower aquifer than in the upper aquifer. The average values are 1.5 mg/l and 15 mg/l, respectively. Most of the water produced during Phase II will be used in processing; the remainder will be used to aid revegetation and in dust control.

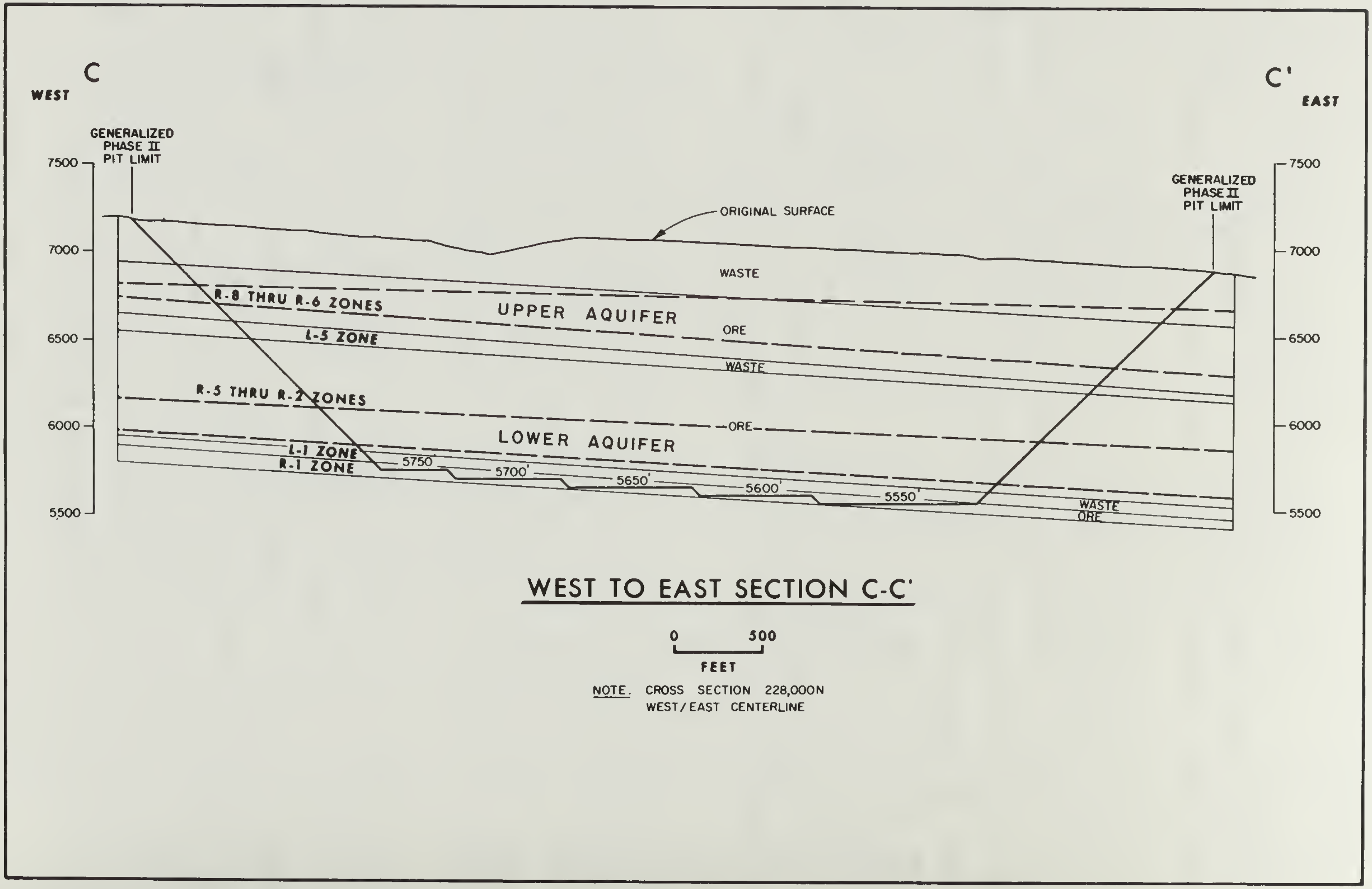


Figure 2-4-3
30-YEAR PIT CROSS SECTION

CHAPTER 5

RETORT FEED PREPARATION

The Tract C-a retort feed preparation facilities will include secondary crushing and screening equipment, and materials transporting equipment necessary to move the ore from the primary crushed stockpile to the retorting plants. The retort feed preparation facilities for Phase I - Stage 1 are designed to provide 10,700 TPSD of minus 3/8-inch crushed oil shale for one TOSCO II retort. Major equipment includes vibratory pan feeders underneath the primary crushed stockpile, covered conveyor belts for transfer of materials from one location to another, enclosed secondary crushing and screening equipment, an enclosed 10-hour capacity storage bin, and an open 24-hour capacity reserve storage pile. All of these facilities, with an exception of the primary ore reclaim facilities and the open storage pile, are designed so that they may be duplicated exactly for Phase I - Stage 2. Stage 2 construction can be carried out without interrupting Stage 1 operations.

Long-term crushing tests of mined oil shale, utilizing equipment similar to that being considered, would lead to the best engineering design of crushers; however, no test data for crushers of this capacity on oil shale are available. Further, it is not practical to mine enough ore for tests of this magnitude on Tract C-a until after approval of this detailed development plan. Therefore, the Stage 1 design is based on data developed from small scale tests previously published by the Anvil Points Research Center, The Oil Shale Corporation and the U.S. Bureau of Mines, as well as data from vendors and manufacturers of crushing equipment. Phase I - Stage 1 will serve to provide long-term crushing test data.

Several problems are thought to be associated with the storage of finely-crushed oil shale in open storage piles. During Phase I - Stage 1 the following problems will be investigated:

- Size segregation in the pile
- Degradation of the ore because of exposure to weather and mechanical handling equipment
- Atmospheric emission of particulates on windy days
- Reduced retort efficiency because of rain, snow or freezing
- The possibility of spontaneous combustion of small ore particles

If these problems can be solved, an obvious advantage to an outdoor, open storage pile would be the reduced cost because enclosures could be eliminated. Phase I - Stage 1 includes a 14,000-ton reserve storage pile immediately adjacent to the surge bin for secondary crushed product. This pile will be used initially to determine long-term atmospheric effects, while the in-line enclosed storage bin will be used for normal operations of the system. Short-term tests will be scheduled late in Stage 1 to investigate the effects of using the open storage pile for normal operations.

Phase II involves the expansion to a production of 55,800 BPSD of upgraded shale oil. Included in this expansion are five additional TOSCO II retorts, for a total of seven, and seven gas combustion-type retorts. Since the TOSCO II retorts use 3/8-inch and smaller pieces of ore, and the gas combustion-type retorts use ore having a size range from 2-1/2 inches to one inch, the Phase II retort feed preparation facilities are more complex than those for Phase I. Included in the Phase II facilities are a traveling bucket wheel reclaimer and hopper cars for primary ore reclaiming, both secondary and tertiary crushing facilities, and separate crushed ore storage bunkers for the GCR and TOSCO feed.

All of the Phase II crushing equipment will be larger than that used in Phase I to take advantage of "economies of scale". Therefore, the retort feed preparation facilities used for Phase I will be dismantled after the successful startup of Phase II. A simplified flowsheet of the Phase II retort feed preparation facilities is shown in Figure 2-5-1.

The only atmospheric emissions expected from the retort feed preparation facilities are particulates, or shale dust. These emissions are expected to be

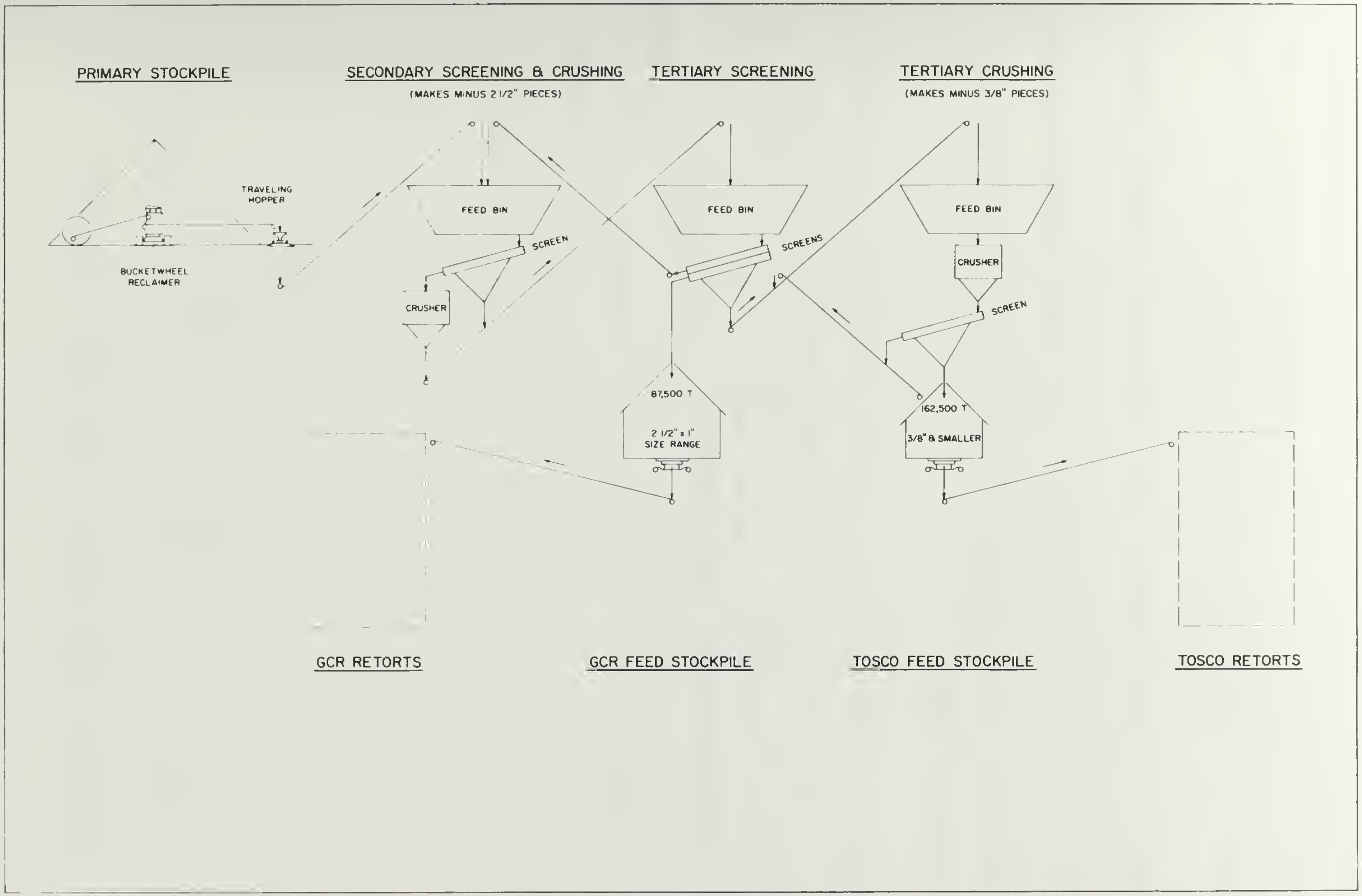
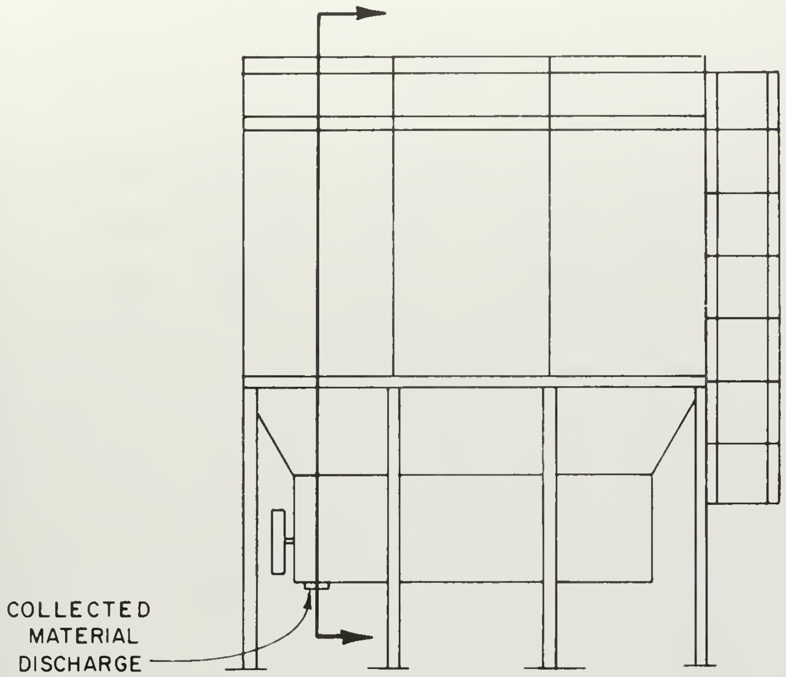


Figure 2-5-1

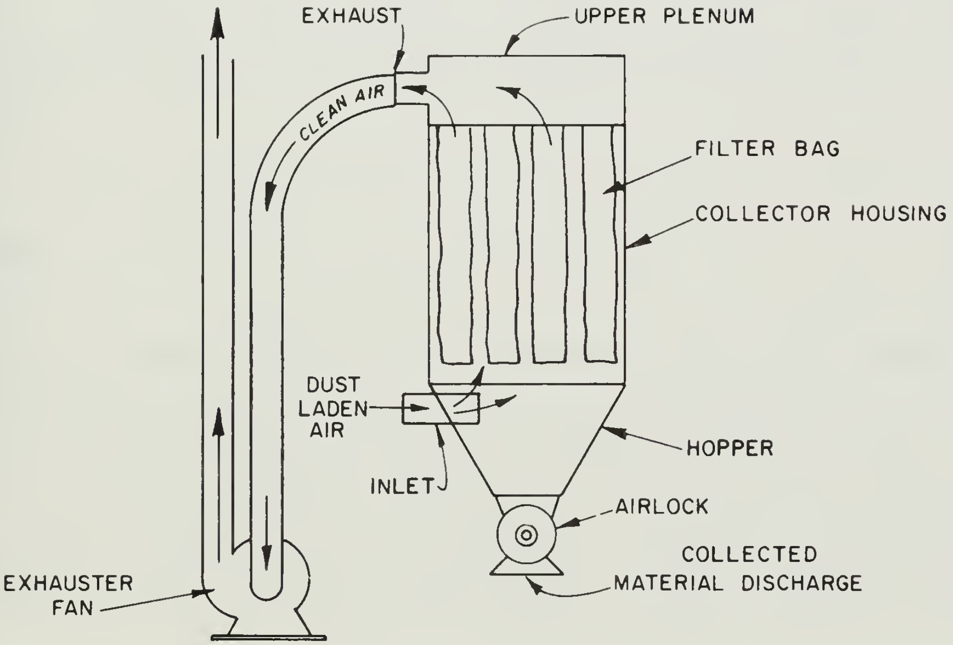
FLOWSHEET OF PHASE II RETORT FEED PREPARATION FACILITY generated at points in the system where a transfer is made; e.g., transferrring from the end of one belt to the start of the next, transferring into a pile or surge bin, or transferring from the crusher to the belt. Three basic concepts have been adopted to reduce these particulate emissions:

- Completely covered conveyor belts to eliminate particulate emissions caused by the wind
- Water sprays at selected transfer points to drop the dust back onto the belts
- Induced-draft fans and baghouse filters for all transfer points and crushing buildings

A simple drawing of a baghouse filter is shown in Figure 2-5-2. Its operation is similar to the operation of a household vacuum cleaner except that dust collects on the outside of the bag. A blower taking suction at the top of the baghouse draws dirty air into the bottom and through bag-type filters. The air flows through the holes in the filters, but most of the dust particles are trapped by the filters and do not escape through the blower. The dust collected is periodically removed and either placed back on the conveyor or slurried to the processed shale moisturizer. Baghouse filters have been applied in many dust-creating industries throughout the world, and are considered the best technology available for reducing particulate emissions for this specific application.



ELEVATION OF TYPICAL BAG HOUSE



TYPICAL SECTION THRU BAG HOUSE

Figure 2-5-2

TYPICAL BAGHOUSE

CHAPTER 6
PROCESSING

In the first chemical step of converting oil shale to useful hydrocarbon energy, the rock is heated to about 900°F in order to quickly decompose the high-molecular weight organic material. Under these conditions, the organic material decomposes to form smaller molecules which, when cooled, are similar to some heavy waxy, high-nitrogen crude petroleums. This heating-decomposing-cooling process is commonly called retorting. The raw shale oil product, a mixture of heavy waxy oils, has unacceptable flow characteristics in pipelines. In addition, the raw shale oil contains suspended processed shale particles and nitrogen compounds which would be detrimental to U.S. petroleum refinery operations, if raw shale oil comprised a significant portion of the total refinery feedstock. Thus, another series of chemical processing steps, called upgrading, is necessary to prepare a feedstock for conventional refining to make motor fuels, home heating fuels, other fuels and chemical products from oil shale. Together, the mechanical equipment plus associated support facilities required for the retorting and upgrading steps are known as the processing facility.

6.1 PHASE I

The Phase I - Stage 1 processing facility will consist of a commercial size TOSCO II retorting plant and oil upgrading plant designed to process 10,700 TPSD of oil shale to produce 4,500 BPSD of pipelineable shale oil. A portion of the raw shale oil produced is thermally cracked and the cracked liquids blended with untreated shale oil fractions to produce the pipelineable shale oil product. Plants included in the Phase I - Stage 1 Facility are as follow:

Plant	Nominal Capacity
TOSCO II Retorting	10,700 TPSD
Raw Oil Recovery	5,000 BPSD
Thermal Cracking	1,700 BPSD
High BTU Gas Plant	8 MMSCFSD
Sulfur Recovery	11 LTPSD
Product Oil Blending	4,500 BPSD

Figure 2-6-1 shows the flow of major streams through the processing facility. Crushed shale is retorted in the TOSCO II plant and the oil and light hydrocarbon vapors produced are separated in the raw oil recovery plant into gas, naphtha, light gas oil, heavy gas oil, and residue fractions. Heavy gas oil is charged to the thermal cracking plant while the residue is centrifuged to remove shale dust. Retort gas and thermal cracker gas are separated in the high BTU gas plant into a C_3 and lighter gas, C_4s and naphtha.

The Phase I - Stage 2 processing facility will consist of additional retorting and oil upgrading plants identical to the Stage 1 processing facility. There will be two 10,700 TPSD TOSCO II retorting plants. Heavy gas oil recovered from the raw oil recovery plants is charged to two thermal cracking plants where cracked distillates are produced, then blended with raw naphtha, light gas oil and residue fractions to produce pipeline quality oil.

Overall material blances and selected product properties for Phase I (Stages 1 and 2) are given in Table 2-6-1.

6.2 PHASE II

The Phase II processing facility will include retorting of oil shale and production of upgraded shale oil at a rate of 55,800 BPSD together with sulfur, coke, and ammonia by-products. The best technology available will be used for Phase II operations. RBOSP currently expects that this will be a combination of TOSCO II and gas combustion-type Paraho retorting. As now planned, the

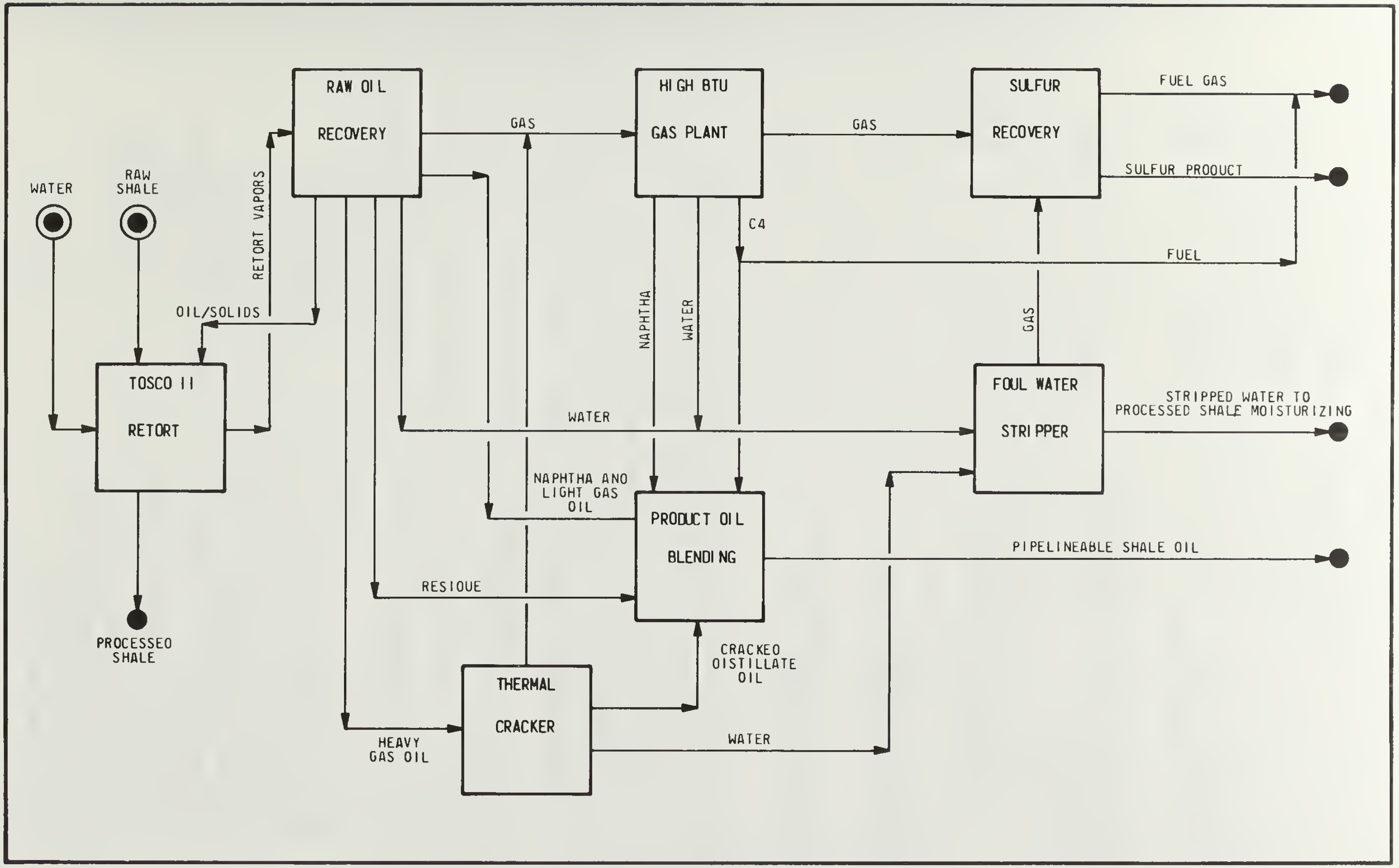


Figure 2-6-1

BLOCK FLOW DIAGRAM OF PHASE I PROCESSING FACILITY

Table 2-6-1

PHASE I MATERIAL BALANCE

	Stage 1	Stage 2
Oil Shale		
Feedrate, TPSD	10,700	21,400
Fischer Assay, GPT	20	20
Pipelineable Shale Oil Product		
Production Rate, BPSD	4,500	9,000
Properties		
°API	28.6	28.6
True Vapor Pressure, psia	8.0 max	8.0 max
Viscosity, SSU @ 30°F	800 max	800 max
Pour Point °F	30 max	30 max
Sulfur By-Product		
Production Rate, LTPSD	11	22
Moisturized Processed Shale		
Production Rate, TPSD	11,000	22,000

Phase II retorting plant will consist of seven TOSCO II retorts (including the two built for Phase I operations) and seven gas combustion-type Paraho retorts The processing operations convert crushed and sized oil shale having an average Fischer assay of 23 gallons per ton (GPT) into a low sulfur, low nitrogen upgraded shale oil, and sulfur, ammonia and coke. The primary waste product is processed shale which is conditioned for disposal. Plants included in the processing facility are:

Plant	Nominal Capacity
Retorting Plant	119,000 TPSD
Raw Oil Recovery Plant	58,000 BPSD
Delayed Coker	8,000 BPSD
Gas Oil Hydrotreater	38,000 BPSD
Naphtha Hydrotreater	21,000 BPSD
Hydrogen Plant	95 MMSCFSD
Oxygen Plant	1,160 STPSD
High BTU Gas Plant	50 MMSCFSD
Low BTU Gas Plant	225 MMSCFSD
Foul Water Stripping Plant	-
Sulfur Recovery Plant	150 LTPSD
Ammonia Recovery Plant	225 TPSD

Figure 2-6-2 is a block flow diagram showing the flow of major streams through the Phase II processing facility. Crushed oil shale is retorted in TOSCO II and gas combustion retort plants. Oil produced by gas combustion retorting and oil plus light hydrocarbons produced by TOSCO II retorting are separated into gas, naphtha, gas oil and residue fractions in the raw oil recovery plant.

A portion of the shale oil residue is charged to a delayed coking plant where coker distillates and coke are produced. Coker gas oil and raw shale gas oil are hydrotreated to remove sulfur and nitrogen compounds in the gas oil hydrotreater. Coker naphtha, raw shale naphtha, and naphtha produced in the gas oil hydrotreater are charged to the naphtha hydrotreater. Hydrogen required from the hydrotreating plants is produced from the remaining shale oil residue in a partial oxidation hydrogen plant.

Light hydrocarbons produced by TOSCO II retorting and gases from delayed coking and hydrotreating are separated in the high BTU gas plant into a fuel gas and a C_4 fraction. Low BTU gas produced by gas combustion retorting is purified in the low BTU gas plant. All of the fuel requirements for Phase II processing are supplied by purified high and low BTU gases plus some purified butanes, all of which are produced in the various processing units.

Low sulfur, low nitrogen upgraded shale oil product is prepared by blending hydrotreated naphtha, hydrotreated gas oil, and butanes. Elemental sulfur and anhydrous ammonia are produced in the sulfur recovery and ammonia recovery plants, respectively.

Water recovered from the raw oil recovery plant and excess water from the low BTU gas plant are stripped in the foul water stripping plant to remove dissolved hydrogen sulfide and ammonia. Stripped water from this plant as well as from the ammonia recovery plant is used for processed shale conditioning. An overall material balance and selected product properties for Phase II processing are given in Table 2-6-2. A water balance showing the disposition of water in Phase II is given in Table 2-6-3. The processing facility is served by various support systems including water treatment, cooling water, steam generation and electric power distribution.

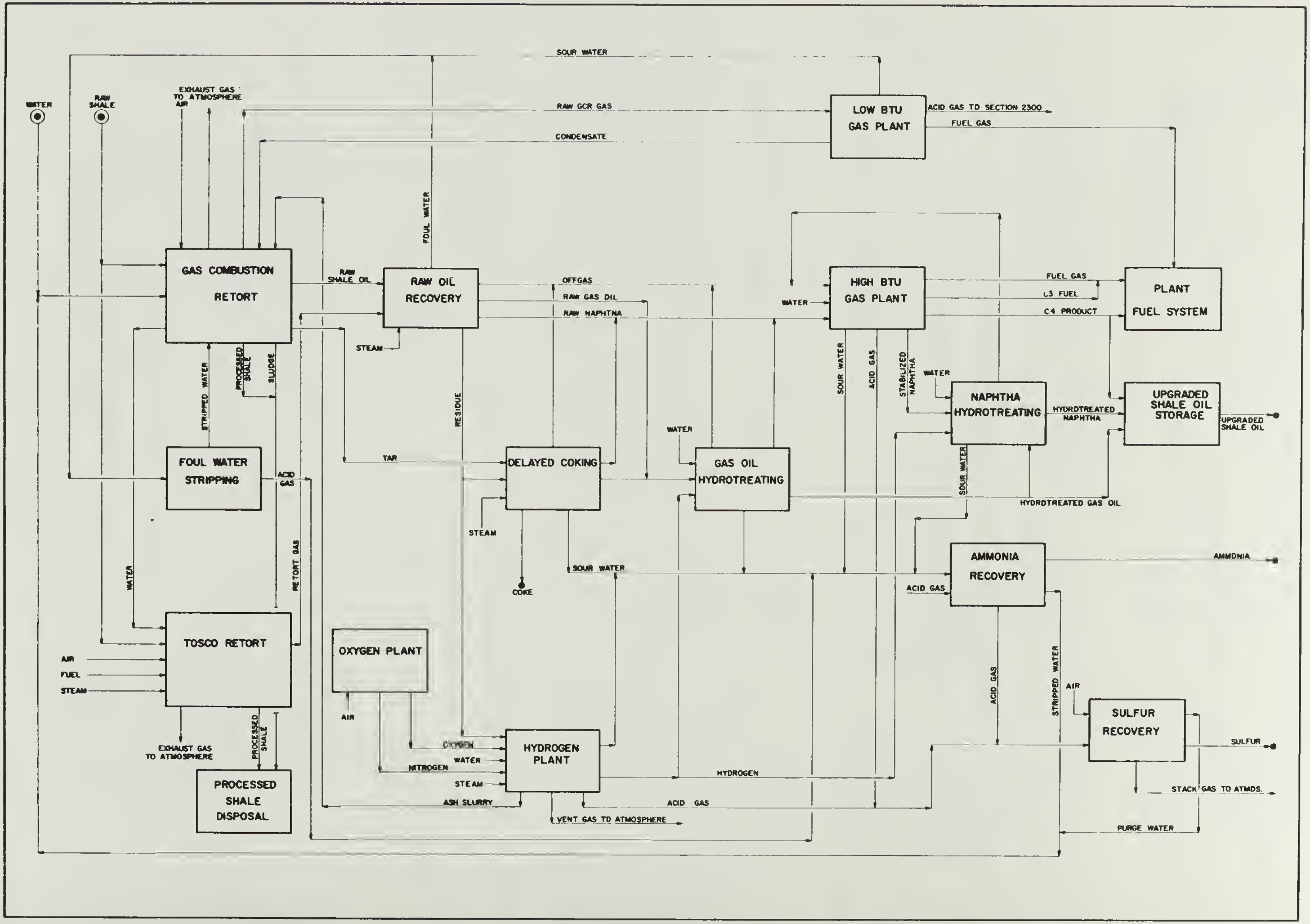


Figure 2-6-2

BLOCK FLOW DIAGRAM OF PHASE II PROCESSING FACILITY

Table 2-6-2

PHASE II OVERALL MATERIAL BALANCE

Oil Shale	
Feed Rate, TPSD, dry basis	119,000
Fischer Assay, GPT	23
Upgraded Shale Oil Product	
Production Rate, BPSD	55,800
Properties	
°API	45.2
Reid Vapor Pressure, psia	5
Sulfur, ppm	10
Nitrogen, ppm	510
Arsenic, ppb	8
Sulfur By-product	
Production Rate, LTPSD	153
Ammonia By-Product	
Production Rate, TPSD, anhydrous	232
Coke By-product	
Production Rate, TPSD	467
Moisturized Processed Shale	
Production Rate, TPSD	118,500

Table 2-6-3

PHASE II WATER BALANCE

Output	gpm	Acre-feet/year*
Water on processed shale	2726	3950
Retort vent gas losses	1992	2900
Cooling water loss	1650	2400
Chemically converted	246	350
Miscellaneous	34	50
Total output	6648	9650
Input		
Raw water intake	5726	8300
Free water on raw shale	298	450
Water produced in retorting	624	900
Total input	6648	9650

*Based on operating factor of 90%

6.3 PROCESSING FACILITY LOCATION

The Phase I and II processing facilities will be located just north of the northern boundary of Tract C-a, as shown in Figure 2-1-2 on page 2-1-8. Figure 2-6-3 is a plot plan showing the locations of the various plants and support systems in the processing facility.

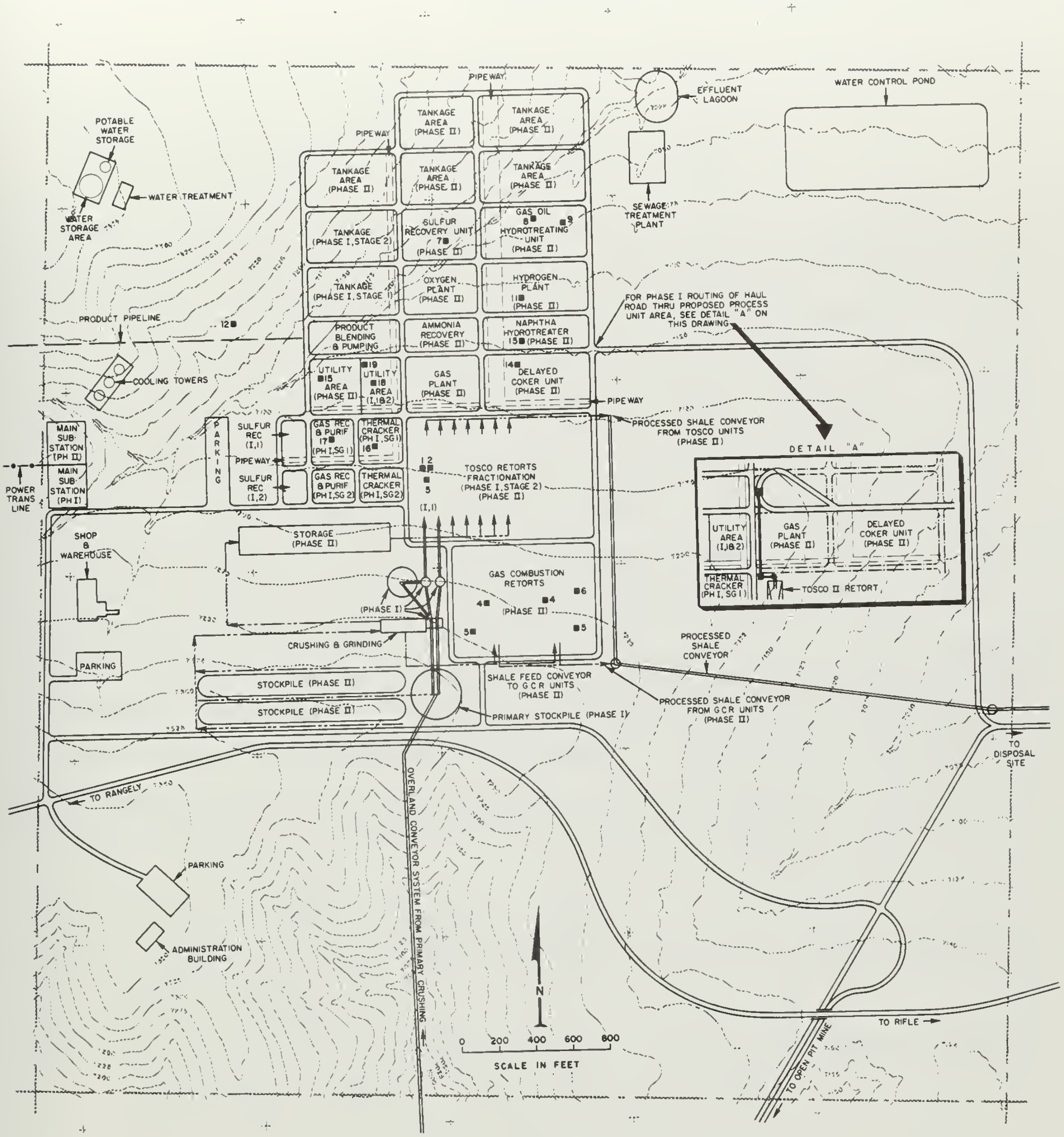

PIPEWAY
TANKAGE AREA (PHASE II)
TANKAGE AREA (PHASE II)
EFFLUENT LAGOON
WATER CONTROL POND
POTABLE WATER STORAGE
PIPEWAY
TANKAGE AREA (PHASE II)
TANKAGE AREA (PHASE II)
TANKAGE AREA (PHASE II)
WATER TREATMENT
WATER STORAGE AREA
SEWAGE TREATMENT PLANT
TANKAGE (PHASE I, STAGE 2)
SULFUR RECOVERY UNIT 7 (PHASE II)
GAS OIL 8 9 HYDROTREATING UNIT (PHASE II)
TANKAGE (PHASE I, STAGE 1)
OXYGEN PLANT (PHASE II)
HYDROGEN PLANT 11 (PHASE II)
FOR PHASE I ROUTING OF HAUL ROAD THRU PROPOSED PROCESS UNIT AREA, SEE DETAIL "A" ON THIS DRAWING
PRODUCT PIPELINE
12
PRODUCT BLENDING & PUMPING
AMMONIA RECOVERY (PHASE II)
NAPHTHA HYDROTREATER 13 (PHASE II)
COOLING TOWERS
UTILITY 15 AREA (PHASE II)
19 UTILITY 18 AREA (I,1&2)
GAS PLANT (PHASE II)
14 DELAYED COKER UNIT (PHASE II)
PIPEWAY
PROCESSED SHALE CONVEYOR FROM TOSCO UNITS (PHASE II)
MAIN SUB STATION (PH II)
MAIN SUB STATION (PH I)
POWER TRANS LINE
PARKING
SULFUR REC (I,1)
PIPEWAY
SULFUR REC (I,2)
GAS REC & PURIF 17 (PH I, SG 1)
THERMAL CRACKER (PH I, SG 1) 16
GAS REC & PURIF (PH I, SG 2)
THERMAL CRACKER (PH I, SG 2)
1 2
3
TOSCO RETORTS FRACTIONATION (PHASE I, STAGE 2) (PHASE II)
5
(I,1)
DETAIL "A"
UTILITY AREA (I,1&2)
GAS PLANT (PHASE II)
DELAYED COKER UNIT (PHASE II)
THERMAL CRACKER (PH I, SG 1)
TOSCO II RETORT
SHOP & WAREHOUSE
STORAGE (PHASE II)
GAS COMBUSTION RETORTS
4
4
6
(PHASE II)
(PHASE I)
5
5
CRUSHING & GRINDING
PROCESSED SHALE CONVEYOR
PARKING
STOCKPILE (PHASE II)
STOCKPILE (PHASE II)
SHALE FEED CONVEYOR TO G C R UNITS (PHASE II)
PROCESSED SHALE CONVEYOR FROM G C R UNITS (PHASE II)
PRIMARY STOCKPILE (PHASE I)
TO DISPOSAL SITE
TO RANGELY
OVERLAND CONVEYOR SYSTEM FROM PRIMARY CRUSHING
PARKING
ADMINISTRATION BUILDING
N
0 200 400 600 800
SCALE IN FEET
TO RIFLE
TO OPEN PIT MINE

Figure 2-6-3

PROCESSING FACILITY PLOT PLAN

CHAPTER 7
PROCESSED SHALE AND OVERBURDEN DISPOSAL

7.1 DISPOSAL SITE ALTERNATIVES AND SELECTION RATIONALE

Development of Tract C-a will require that large volumes of overburden and sub-ore from open pit mining and processed shale from above ground retorting be placed outside of the open pit mine until such a time that backfilling of the open pit with overburden, sub-ore and processed shale can begin. Considering the Phase II mining and processing rate, it is currently estimated that about 30 years of out-of-pit disposal will be required prior to the time that open pit backfilling can begin. As final slopes are established on the off-tract disposal area it will be progressively reclaimed so that at the time that backfilling of 100% of the waste material into the open pit is begun the off-tract disposal area will have been contoured commensurate with surrounding topography and completely revegetated. The backfilled portion of the open pit will also be progressively reclaimed and revegetated so that at the conclusion of the open pit operations on Tract C-a, the backfilled area will also have been rehabilitated. Selecting the most desirable location for the disposal of overburden, sub-ore and processed shale from surface retorting prior to pit backfilling required consideration of the following criteria:

- Minimum regional environmental impact.
- A site of sufficient size to contain all material to be disposed of prior to backfilling.
- Location in which overburden, sub-ore, and processed shale could be stabilized and rehabilitated as soon as possible.
- Maximum recovery of the oil shale resource.
- Reasonable proximity to the mine.

RBOSP believes that off-tract disposal will best satisfy the above criteria. On-tract disposal of overburden, sub-ore and processed shale is considered by RBOSP to be undesirable because:

- On-tract disposal would cover relatively shallow Tract C-a oil shale resources. As a result the open pit would be severely limited in size which would, in effect, minimize potentially recoverable resource. Underground room-and-pillar mining of the remaining oil shale in rich zones (processed shale would be disposed of in pit) could supplement the resource recovery from the restricted pit. However, RBOSP estimates that the resource recovery from the combined restricted open pit mining and the supplemental room-and-pillar mining would only be about one fourth of the total resource recoverable from Tract C-a by open pit mining with off-tract disposal.
- Maximum resource recovery from Tract C-a would require continued rehandling of temporary on-tract disposal piles of overburden, sub-ore, and processed shale, which would increase costs significantly.
- Rehandling of temporary disposal piles of overburden sub-ore and processed shale would complicate and delay rehabilitation.
- Segregation and stockpiling of sub-ore would be difficult and costly because of limited space and necessary rehandling required for maximum resource recovery.
- Rehandling of material would increase dust emissions. Dust control would therefore be more difficult and costly.

Maximum resource recovery consistent with maximum resource conservation for Tract C-a requires off-tract disposal of overburden, sub-ore, and processed shale prior to backfilling of the open pit. In order to locate a suitable disposal area, RBOSP evaluated 16 sites on the basis of environmental factors, capacity, operational feasibility and overall economics. The 84 Mesa area, located north and east of the tract and shown as alternative No. 9 on Figure 2-7-1, was selected as the site which best satisfies the requirements for off-tract disposal.

7.2 PHASE I DISPOSAL OPERATION

The disposal plan for Phase I is based on mining and retorting production schedules for Phase I. Mining and disposal of overburden and sub-ore is

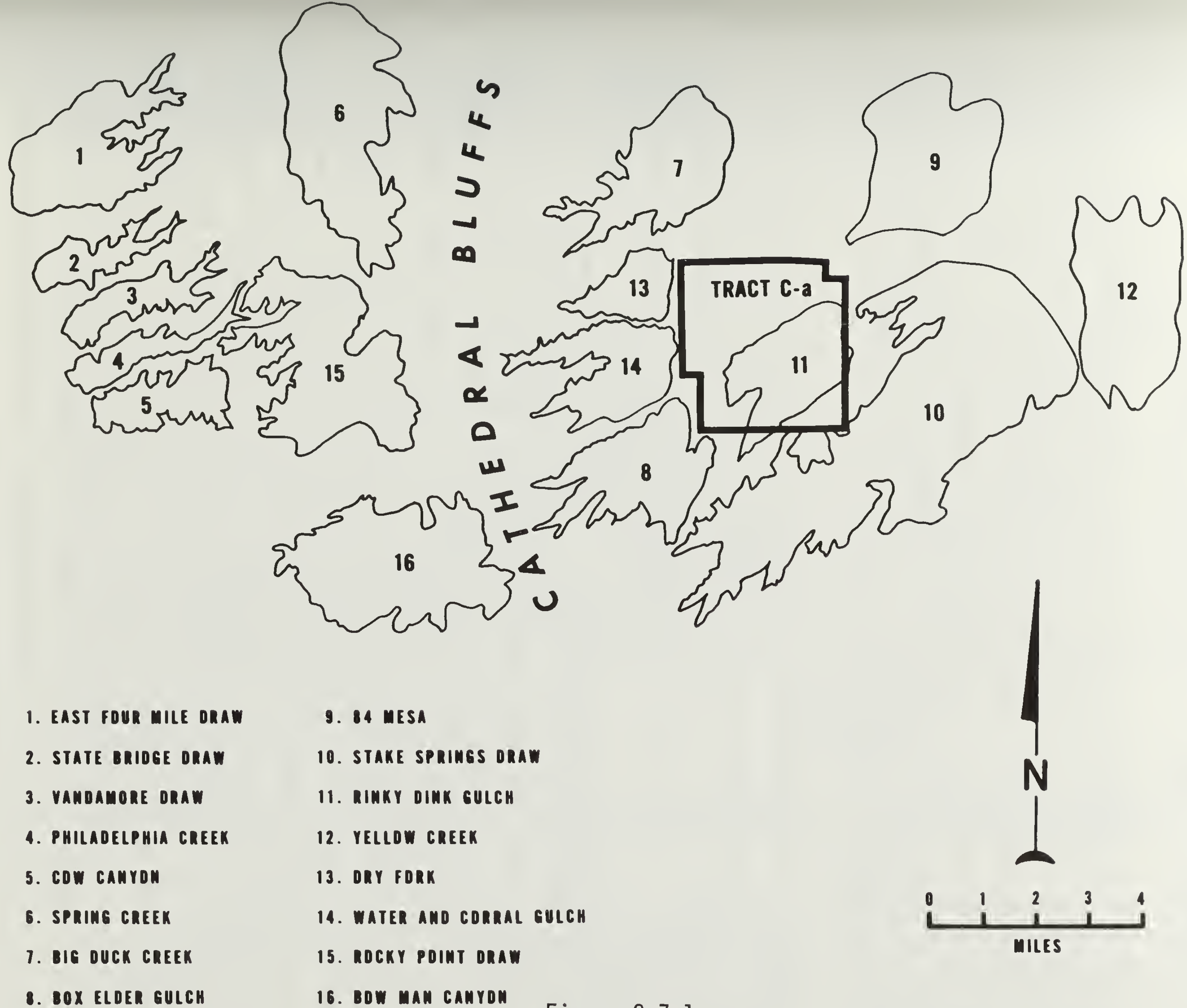


Figure 2-7-1

ALTERNATIVE DISPOSAL SITES

scheduled to begin in June of 1978. Disposal of processed shale is scheduled to begin 14 months later, in August of 1979, when the first TOSCO II retort is operational and ore grade oil shale is fed to the retort.

The physical characteristics of the processed shale, overburden and sub-ore which are necessary to the design of a disposal pile were determined prior to disposal pile planning. The TOSCO II processed shale produced during Phase I is a very fine material; screen analysis indicates that over 50 weight percent of the material will pass a 100-mesh screen. Overburden and sub-ore is very coarse, being run-of-mine (ROM) material; screen analysis indicates that 10 weight percent of ROM material will not pass an 18-inch screen and that only 5 weight percent will pass a 1/2-inch screen.

The proposed site for disposal of processed shale overburden and sub-ore for Phase I is located in the southwest corner of the 84 Mesa disposal area as shown on Figure 2-7-2. A storage area of 355 acres will be required to contain the volume of the three materials produced during Phase I. Disposal operations will begin by stripping and stockpiling the soil and sub-soil from an area that will be used initially in the disposal pile construction. Placement of overburden and sub-ore by truck will begin in June 1978, in the southwest corner of the disposal area. The total compacted overburden and sub-ore volume for the Phase I operation is about 31 million cubic yards. Sub-ore will be disposed of on the west side of the pile as shown on Figure 2-7-2 to facilitate recovery in the event the sub-ore becomes commercial. Constructed side slopes will be dressed to a final slope of 4:1 for effective revegetation. Processed shale, beginning in August 1979, will be hauled by bottom dumping trucks or scrapers and then dumped and compacted in about two-foot lifts on the north end of the Phase I disposal site as also shown on Figure 2-7-2. Total compacted processed shale volume for the Phase I operation is about 21.5 million cubic yards. Soil and sub-soil will be stripped ahead of the advancing disposal pile working face and redeposited as required for revegetation of the disposal pile. The soil stockpile will be revegetated and then later used in reclamation as disposal operations cease on 84 Mesa. This procedure of initially stockpiling a small amount of soil and utilizing freshly stripped soil for on-going revegetation during operations will insure maximum soil fertility.

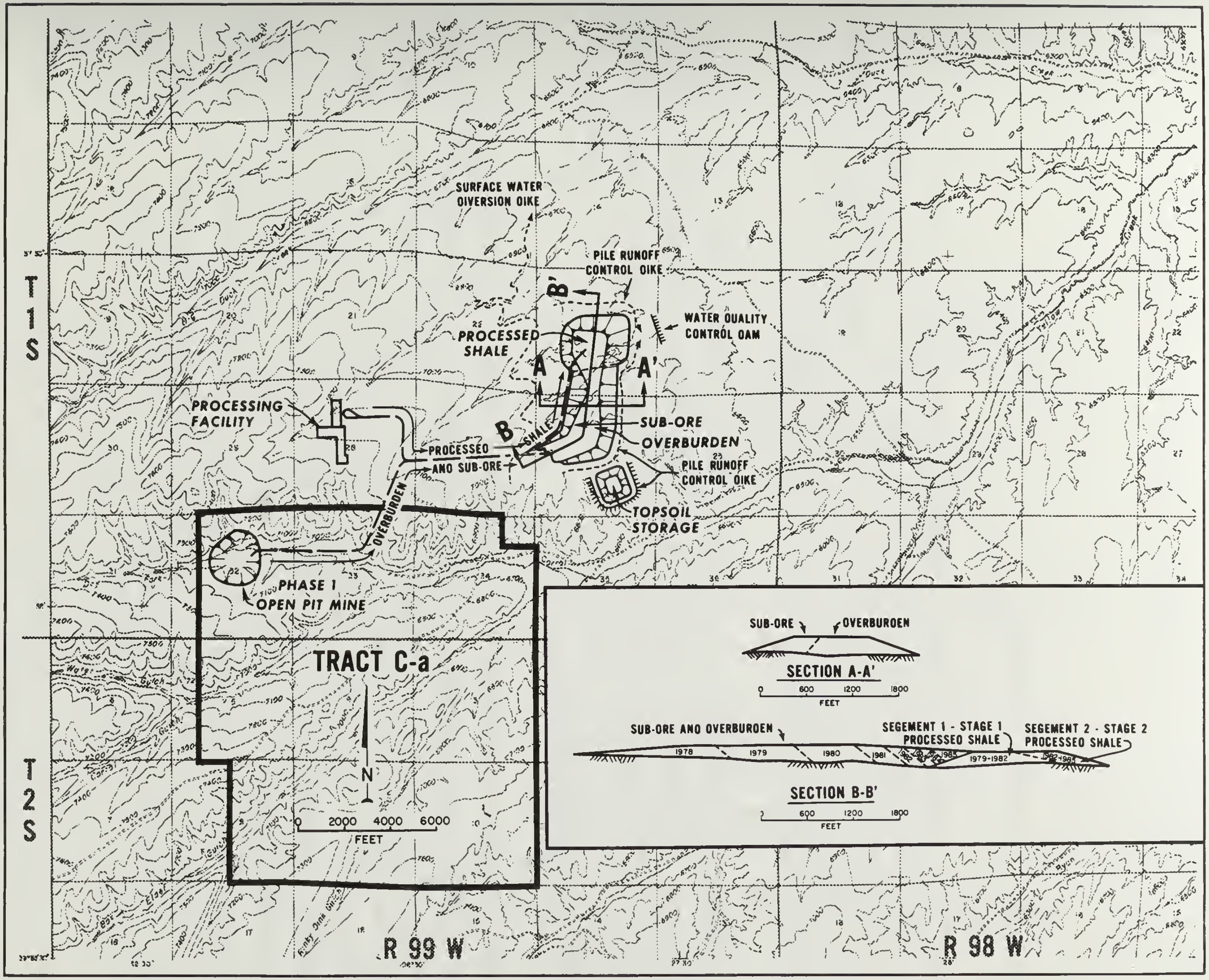


Figure 2-7-2

PHASE I DISPOSAL PLAN

Phase I overburden and sub-ore disposal pile construction will proceed such that the overburden eventually will cover processed shale as shown on section B-B' of Figure 2-7-2. The locations of water control structures are also shown on Figure 2-7-2.

7.3 PHASE II DISPOSAL OPERATIONS

Transition to the larger Phase II disposal operations will be accomplished without significantly altering the basic disposal pile design. Phase II disposal plans will be amended as necessary to incorporate the technology developed during Phase I to ensure that Phase II disposal practices will conform to the technical, environmental, and regulatory requirements.

The physical characteristics of processed shale produced during Phase II will change as the Phase II retorting will be accomplished by seven TOSCO II retorts and seven gas combustion-type retorts. The processed shale will, therefore, be a mixture of approximately 65% TOSCO II processed shale and 35% gas combustion-type processed shale.

Phase II disposal operations will expand from Phase I operations with system modifications to compensate for additional quantities of processed shale, overburden and sub-ore. The disposal operation will extend to the north and east from the Phase I disposal pile located in the southwest corner of the 84 Mesa disposal area. Figure 2-7-3 presents a disposal pile commensurate with surrounding topography that is in line with RBOSP thinking, which is capable of holding the disposal volume presently thought necessary prior to backfilling of the open pit. About 3,650 acres will be required for Phase II disposal pile construction. Final disposal pile configurations will be developed in final Phase II designs based on knowledge gained from the Phase I disposal operation. The initial Phase II soil and sub-soil stockpile will cover about 25 acres.

Three distinct, but connected disposal areas will be developed for processed shale, sub-ore and overburden. Processed shale consisting of TOSCO II and gas combustion-type processed shale will merge at a central transfer facility and

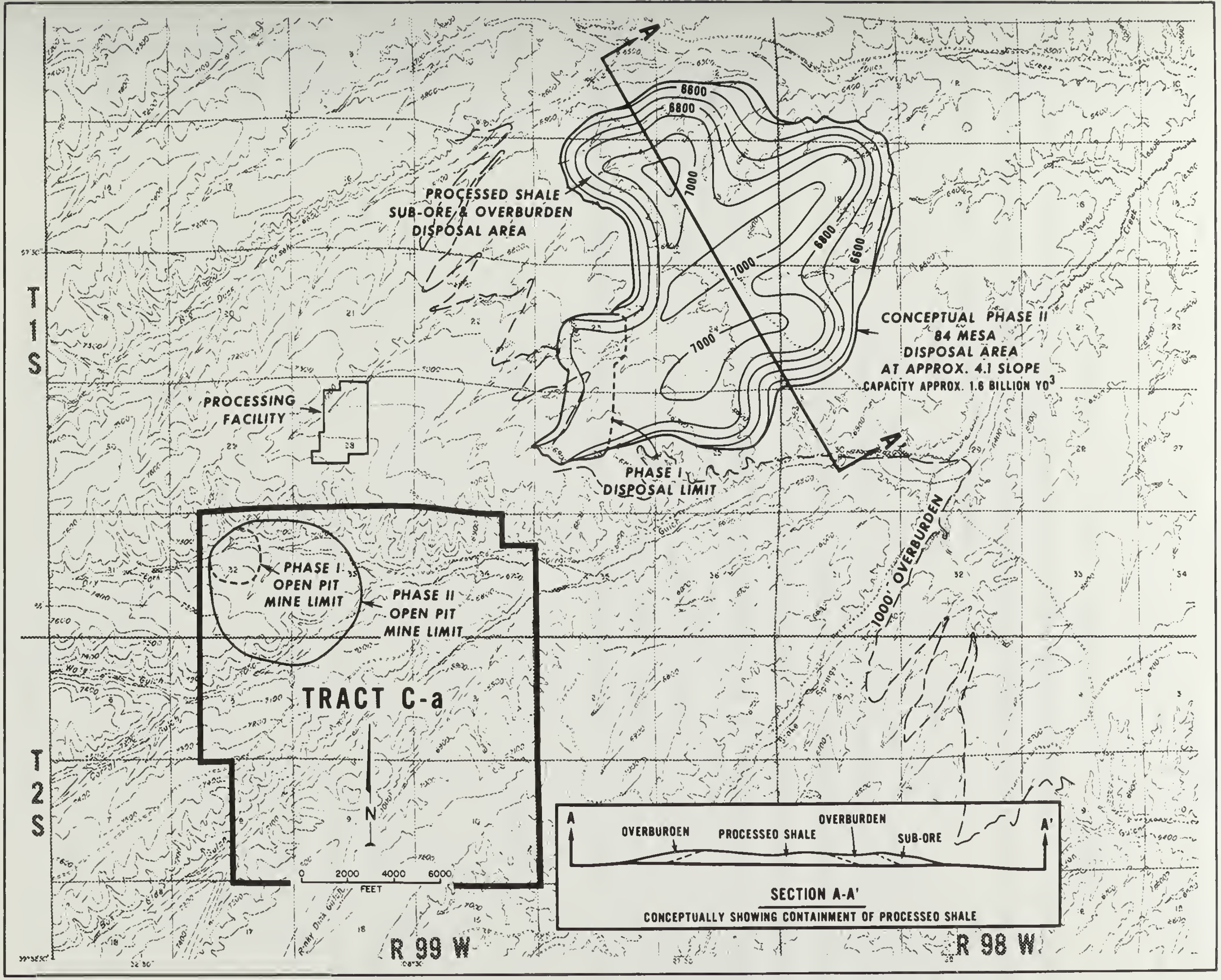


Figure 2-7-3

CONCEPTUAL PHASE II DISPOSAL PLAN DESIGNED TO BLEND WITH NATURAL TOPOGRAPHY from there be transported by an overland conveyor to the disposal area. The processed shale will be loaded into trucks and the trucks will haul and dump the processed shale in about two-foot lifts along the surface of the disposal pile. The processed shale will then be compacted and exterior surfaces sloped at 4:1. The entire processed shale pile will eventually be enclosed by overburden. The sub-ore and overburden will be crushed at the mine to a nominal 8 inches and transported separately to the 84 Mesa disposal site by a dual overland conveyor system. At the disposal area overburden and sub-ore will be transferred to movable stackers which will deposit the material in separate but connected piles. The sub-ore will be deposited along the exterior of the pile to facilitate reclaim should the material become commercial. Exterior sloping surfaces of overburden and sub-ore will be constructed to a 4:1 slope. An artificial soil profile will be placed on final surfaces to aid reclamation. Total volume of compacted processed shale for both Phase I and Phase II will be approximately 915 million cubic yards. Total volume of compacted sub-ore and overburden will be approximately 593 million cubic yards. As development of the disposal pile progresses, RBOSP will maintain an on-going program to ensure the overall stability of the disposal pile final slopes and working surfaces.

CHAPTER 8
SUPPORT FACILITIES

Support facilities for development of Tract C-a will include roads, a power transmission line, a water supply and distribution system, a product pipeline, a communications system, fuel storage, and several buildings.

The locations of most project support facilities are, of course, dictated by the locations of the major project features: the mine, the processing facility, and the overburden and processed shale disposal area. Areal relationships among these facilities are shown in Figures 2-1-2 and 2-1-3 which also depict routes of the product pipeline, power tranmission line and the Ryan Gulch and Rangely access roads.

8.1 TRANSPORTATION

The bulky machinery and equipment to be used or installed during construction, plus materials and supplies necessary for construction and operation, will originate outside the northwest Colorado area. Whatever their origin, heavy and/or bulky items will probably be shipped by rail. There is currently no rail service into the interior of the Piceance Creek basin and none is planned by RBOSP. The nearest rail heads, both Denver and Rio Grande Western Railroad (D&RGW), are a spur line at Craig and the mainline at Rifle. Because highway distance from Rifle to Tract C-a is some 50 miles shorter than from Craig to the tract and because Rifle is on the mainline rather than a spur, the logical choice as a destination for goods shipped by rail to Tract C-a is the Rifle area. A new railroad siding will be built somewhere in the vicinity of Rifle to handle the rail traffic serving Tract C-a. RBOSP is currently in the process of selecting an exact location for the siding. Goods will be loaded on trucks at the siding, then transported to the tract. Goods shipped entirely by truck can reach the corridor serving Tract C-a by a number of different routes. Trucks originating in Salt Lake City or points west will likely reach the tract via

Vernal and Rangely rather than swinging south through Grand Junction and Rifle. Trucks from Denver and other points east or south, which will likely constitute most of the truck traffic serving Tract C-a, will pass through Rifle on their way to the tract. Thus, Rifle will likely be a focal point for truck, as well as rail transportation, both during construction and operation.

Most of the Tract C-a construction and operating personnel are expected to reside in Rangely. The Rangely access road will reduce the current highway distance from Rangely to Tract C-a by more than 40 miles and thus substantially reduce commuting time. For those choosing to live in Meeker or Rifle, the commuting distance will not change from what it is now.

The principal highway route serving Tract C-a will extend from Rifle on the southeast to Rangely on the northwest. The route follows State Highway 13 from Rifle to Rio Blanco then turns northwest on the Piceance Creek road to Ryan Gulch. It follows the Ryan Gulch road west to the historic Ryan Gulch School then turns northwest over the Yellow Creek-Piceance Creek divide and on west to the processing facility at Tract C-a where it connects with the planned Rangely access road. It follows the Rangely access road to State Highway 64, then west to Rangely. Other roads and highways in the area will carry very little traffic directly associated with the Rio Blanco Oil Shale Project.

8.2 POWER SUPPLY

Power demand by the Rio Blanco Oil Shale Project, by year, is estimated to be as follows:

Year	Power Demand MW
1977	0.4
1978	2.9
1979-1981	17.7
1982-1984	28.8
1985	227

Installation of power and communications lines actually will begin in 1976, but power won't be needed at the tract until mine development and construction of the processing facility begin in 1977. The power needed during construction will be about 0.4 MW in 1977 and about 2.9 MW in 1978. Power demand will then increase to 17.7 MW in 1979 when Phase I - Stage 1 operations begin, and will again increase to 28.8 MW in 1982 when Phase I - Stage 2 operations begin. Phase II power demand will be about 227 MW, beginning in 1985.

Tract C-a is located within the service area granted to Moon Lake Electric Association, Inc., by the Colorado Public Utilities Commission. Moon Lake is thus the exclusive distributor of electricity to the Rio Blanco Oil Shale Project.

As of January 1975, Moon Lake owned and operated a total of 331 circuit miles of 69-KV and 138-KV transmission lines with a total system load of about 60 MW. Its present generating facilities consist of two small hydroelectric plants with a combined output of 2.1 MW. The Association has historically satisfied the bulk of its system requirements by purchasing power from wholesale suppliers. Moon Lake is a member of the Intermountain Consumer Power Association, and through this association, purchased most of its power for resale during 1974 from the Colorado River Storage Project of the U. S. Bureau of Reclamation. Moon Lake is currently buying additional power from Utah Power and Light and plans to use this source to satisfy Phase I RBOSP requirements.

Phase II power demand at Tract C-a dictates the need for a 230-KV transmission line. Moon Lake's basic plan is to tap an existing 138-KV line on the White River approximately eight miles east of Rangely. Some 20 miles of single-circuit, 230-KV transmission line will be built between there and Tract C-a. This line will be operated at 138-KV during construction and Phase I operations. Phase II demand will require conversion of the line to 230-KV operation. Several alternatives are being considered by Moon Lake to provide the required 230-KV for Phase II at the White River tap point.

In addition to providing additional power for Phase II demand, it will probably be necessary to ensure power reliability for Phase II by running a second 230-KV line to Tract C-a. Such a backup line could come from a White River tap point or preferably from a looped connection with other utility companies such as Colorado-Ute Electric's existing 230-KV line near Rio Blanco. This latter alternative would provide much greater reliability.

8.3 PRODUCT PIPELINE

The primary product from the Rio Blanco Oil Shale Project (pipelineable shale oil in Phase I and upgraded shale oil in Phase II) will be transported to Amoco's pipeline facilities near Rangely via a 26-mile, 10-inch product pipeline to be built in 1978. From there it will be transported through Amoco's existing 10-inch pipeline to other connecting carriers for ultimate delivery to refineries in the west and midwest. The only possible exception to this plan is that the shale oil may be trucked to a nearby Colorado refinery during Phase I. Should this occur, construction of the pipeline will probably be postponed until Phase II. By-product ammonia, coke and sulfur will be shipped from the RBOSP complex by truck.

Although Phase I - Stage 1 shale oil production from the processing facility is planned to be 4,500 BPSD, the product pipeline will be designed for an initial capacity of 7,500 BPSD to provide operating flexibility. By installing additional pumping equipment and modifying operations, capacity will be increased to 15,000 BPSD during Phase I - Stage 2 and again increased to 55,800 BPSD for Phase II. The entire system will be designed to be easily expandable to a capacity of 75,000 BPSD.

Wherever feasible, the pipeline will be installed immediately adjacent to the Rangely access road until the road swings north about 3-1/2 miles southeast of Rangely to connect with State Highway 64. At this point, the pipeline will continue to the west, then gradually swing to the northwest across the White River and terminate at Amoco's pump station about two miles west of Rangely.

When the pipeline forks away from the Rangely access road, it will follow other utility lines in established corridors for the remaining distance to the Amoco pump station.

The pipeline will be fed from a blending station at the Tract C-a processing facility. At the Rangely end of the pipeline, the product will be stored in a new 40,000-barrel tank in order to segregate the shale oil from other oil in Amoco's pipeline system. An additional 40,000-barrel tank will be required at Rangely for Phase II, but the blending station at Tract C-a will be adequate for both Phase I and Phase II.

Shutoff valves installed at both ends of the pipeline will be equipped with motor operators to facilitate remote and quick shut-off in the event of an emergency or accident. Other valves will be located at the Tract C-a pumping station (this will be an automatic station shutdown valve); at the head of East Spring Creek; on both sides of Douglas Creek; on both sides of the White River; and, at Amoco's Rangely delivery station. Initially, the pipeline will probably be operated from Tract C-a. Later, the pipeline will be operated remotely, probably from Amoco's remote system operation at Casper, Wyoming.

8.4 WATER SUPPLY AND DISTRIBUTION

A. Demand - Estimated maximum water requirements (in acre-feet per year) for Phases I and II are:

	Phase I		
Use	Stage 1	Stage 2	Phase II
Processing	975	1,950	8,300
Potable	15	20	50
Irrigation	100	100	550
Dust Control	300	300	1,100
Total	1,390	2,370	10,000

About 70 to 80% of the estimated water demand is attributable to the processing facility. These requirements include water for boiler feed, cooling, moisturizing processed shale, operation of retort scrubbers and miscellaneous uses. Approximately 40% of the total process water input is consumed in moisturizing processed shale. Evaporation losses from TOSCO retort scrubbers and cooling towers account for almost all of the remaining water input; about 4% is chemically converted during processing in Phase II.

Expansion beyond the Phase II shale oil production level of 55,800 BPSD would require additional water at the rate of approximately 10,000 AFY per 50,000 BPSD of shale oil production. The water demand for a 300,000 BPSD production level, for example, would be about 60,000 AFY.

B. Supply - The water supply for development of Tract C-a through Phase II will come from a mine dewatering system, supplemented as necessary by other ground water wells on the tract. Expansion beyond the Phase II production level of 55,800 BPSD will probably require the development of surface water supplies to augment Tract C-a ground water sources.

As now planned, the Phase I mine dewatering system will consist of eight wells lining the perimeter of the open pit. Maximum dewatering requirements in Phase I are projected to be about two cubic feet per second (cfs). The Phase I project water requirements are equivalent to approximately 1.9 and 3.3 cfs for Stage 1 and Stage 2, respectively. Thus, mine water alone will not be sufficient to meet Phase I demand and will have to be supplemented by additional ground water wells located east of the Phase I open pit. These wells will eventually be abandoned as the open pit expands during Phase II.

The mine dewatering system will be continually modified with the addition of new wells and abandonment of old ones as the open pit grows larger and deeper throughout Phase II operations. Current data indicate that, during the early years of Phase II, mine dewatering will be insufficient to meet total project water demands and supplemental wells will continue to be used. Eventually, however, mine dewatering is expected to provide more than enough water for the projected demand. Beginning about eight or nine years after Phase II begins, mine dewatering is expected to produce between 11,000 and 14,000 AFY which is equivalent to about 15 to 20 cfs.

The Yellow Creek reservoir would be the key feature of a surface water system if expansion beyond Phase II production levels occurs. The Yellow Creek dam would be located on Yellow Creek about four miles south of its confluence with the White River and about 14 miles northeast of Tract C-a. Water would be diverted from the White River at a point about 25 miles downstream of Meeker and pumped to the Yellow Creek reservoir for storage. From there, the water would be pumped uniformly throughout the year in a buried pipeline to Tract C-a.

The Yellow Creek reservoir would be developed in stages, as necessary, to provide regulation of flows diverted from the White River at relatively high rates during periods of surplus flows. A dam height of some 240 feet would create a storage capacity of about 138,000 acre-feet. By building the dam another 100 feet higher, storage capacity would be tripled to more than 400,000 acre-feet.

C. Water Distribution at Tract C-a - The water distribuiton system is depicted in Figure 2-8-1 and will be continually modified and expanded as operations progress. Basically, ground water from the mine dewatering system (and supplementary water wells when needed) will be conveyed to a central collection point east of the open pit mine, then pumped throughout the project area to points of use. Two treatment plants and storage tanks for providing potable water needs are contemplated: one will be located near the processing facility and will serve that facility and the administration building; the other will be located east of the mine to serve the mine changehouse, truck shop and equipment-wash facility.

A storage pond will be located near the processing facility; water from this pond will either be fed to the potable treatment plant or conveyed directly to points of use throughout the processing facility.

Irrigation and dust-control water will also be supplied from the central collection point and will be stored in two tanks: the one located near the mine

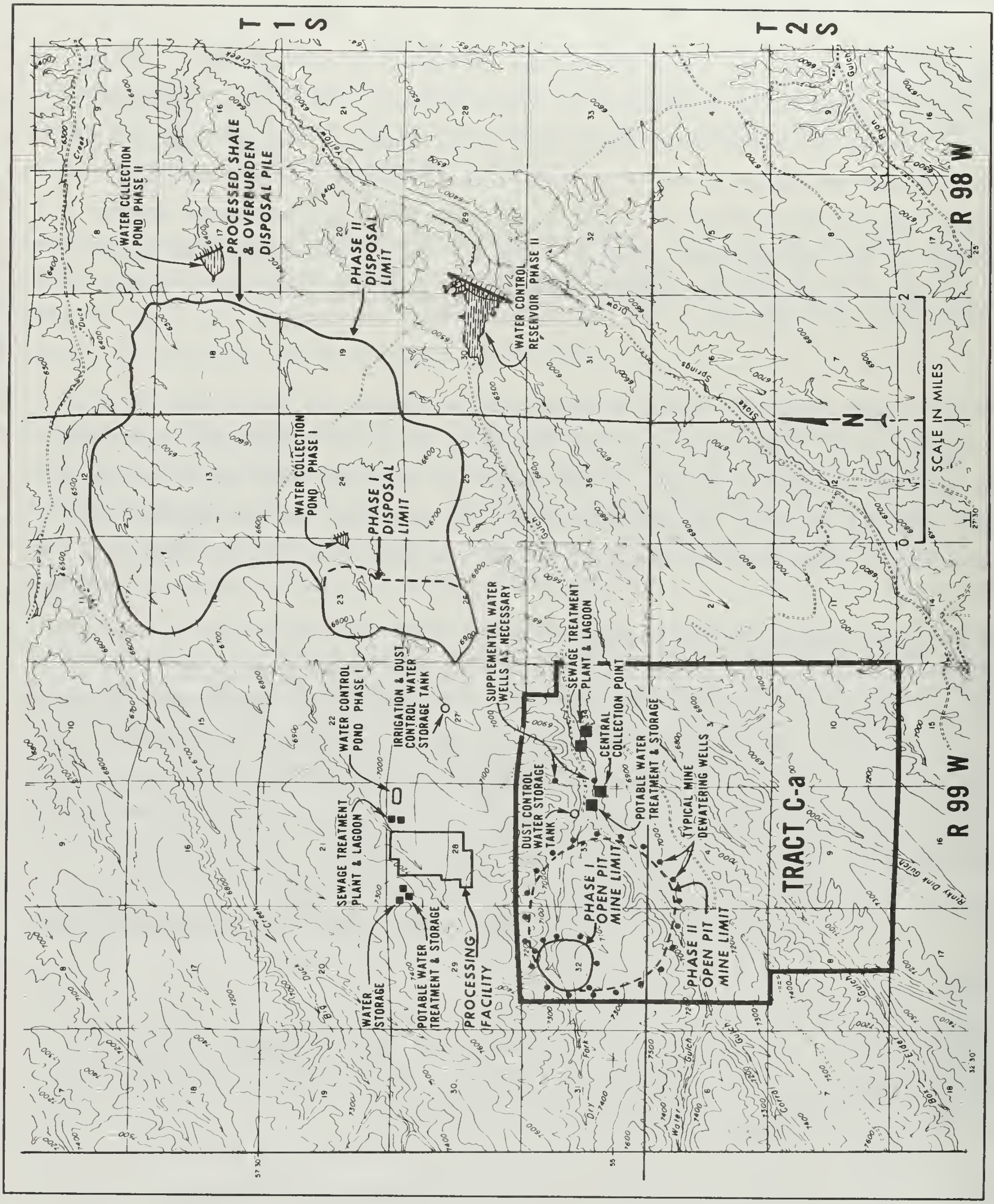

T 1 S
T 2 S
R 99 W
R 98 W
WATER COLLECTION POND PHASE II
PROCESSED SHALE & OVERBURDEN DISPOSAL PILE
PHASE II DISPOSAL LIMIT
WATER CONTROL RESERVOIR PHASE II
WATER COLLECTION POND PHASE I
PHASE I DISPOSAL LIMIT
SEWAGE TREATMENT PLANT & LAGOON
WATER CONTROL POND PHASE I
IRRIGATION & DUST CONTROL WATER STORAGE TANK
SUPPLEMENTAL WATER WELLS AS NECESSARY
SEWAGE TREATMENT PLANT & LAGOON
CENTRAL COLLECTION POINT
POTABLE WATER TREATMENT & STORAGE
DUST CONTROL WATER STORAGE TANK
WATER STORAGE
POTABLE WATER TREATMENT & STORAGE
PROCESSING FACILITY
PHASE I OPEN PIT MINE LIMIT
TYPICAL MINE DEWATERING WELLS
PHASE II OPEN PIT MINE LIMIT
TRACT C-a
N
0
2
SCALE IN MILES
Duck Creek
Yellow Creek
Big Duck Creek
Stake Springs Draw
Corral Gulch
Box Elder Gulch
Water Gulch
Dry Fork
Rinky Dink Gulch
Ryan Gulch

Figure 2-8-1

WATER SUPPLY AND DISTRIBUTION

will be used for dust control only; the other will be located near the processed shale and overburden disposal area and will serve both irrigation and dust-control requirements.

Surface runoff will be controlled throughout the project area. Diversions around the mine, processing facility, and disposal pile will be provided. Surface water originating outside the project area will be diverted completely around RBOSP facilities and returned to an existing watercourse downstream. Surface runoff originating within the RBOSP area will be controlled and will not be released to downstream watercourses unless its quality is shown to be adequate.

A water control reservoir on Corral Gulch about four miles east of the eastern tract boundary will probably be required several years after Phase II begins. Its primary purpose will be for regulation and nominal storage of ground water from mine dewatering but it could also serve to store excess water when the processing facility is, for one reason or another, not operating. Such storage is necessary because mine dewatering will continue whether the processing facility is operating or not.

During Phase I and the early years of Phase II, a smaller water reservoir for this purpose will be located at the northeast edge of the processing facility. During periods when the processing facility is either shut down or operating at reduced capacity, ground water can be pumped directly to this reservoir rather than the storage pond for processing water.

Ultimate design of the water distribution system on Tract C-a will reflect a continuing philosophy of zero discharge.

D. Water Right Acquisition - RBOSP has conducted an active program of securing rights to ground and surface water supplies needed for Tract C-a development within the prior appropriation doctrine under which Colorado administers the use of its water. The program has been guided by three assumptions, each of which has been confirmed by engineering studies:

- Water requirements would increase with project expansion from about 1,390 AFY in Phase I to about 10,000 AFY in Phase II and could reach 60,000 AFY if expansion beyond Phase II occurs.
- Ground water would be used to the maximum extent practicable for both environmental and economic reasons.
- A surface water system to back up and supplement the ground water should be developed from the White River.

RBOSP filed an application to appropriate ground water with the Colorado District 5 Water Court in Glenwood Springs in December 1974. The original application claimed 41 dewatering and water development wells, each for 1.5 cfs, to be spaced uniformly throughout Tract C-a, plus a similarly designed replacement well system. The application noted that the number, location and capacity of the wells were subject to change pending mining studies, dewatering analyses, and related investigations. By mid-1975, these studies had progressed far enough to warrant submittal of an amended application which claimed a total of 96 wells for Phase I and Phase II development. Applications for permits to construct the 96 wells were filed at the same time with the Colorado State Engineer. RBOSP now intends to file a second amended application to further refine the mine dewatering system design and effect a better balance between dewatering requirements and projected water needs.

As suggested by the Court, RBOSP plans to continue negotiations towards formulating a consent decree agreeable to all parties in the case. If successful, a consent decree would be submitted for the water court's consideration. The decree will be based on the second amended application and other supporting data and analyses. If agreement cannot be reached on all issues, the unresolved matters will be submitted to the water court for judicial determination. Meanwhile, the State Engineer issued a denial of the well permit applications, RBOSP entered a protest to this ruling and this protest is still pending.

RBOSP filed applications for a storage decree and reservoir right-of-way for Yellow Creek reservoir in early 1974. The water referee subsequently entered a conditional decree for the full 428,000-acre foot capacity of the reservoir. Processing of the ROW application by the Bureau of Land Management has since been deferred, upon RBOSP's request, pending determination of other ROW needs. An application was also submitted to the Water Court for a 300 cfs water right on the White River and a conditional decree (dated 1974) was subsequently entered by the referee.

The 300 cfs right would allow RBOSP to divert from the river at a rate of about 18,000 AF per month during periods of high flow (about three months during late spring and early summer) to obtain the estimated maximum needs of 60,000 AFY.

The average annual flow of the White River, some 560,000 AF, is sufficient to supply this amount since current depletions amount to only about 60,000 AFY; however, there are numerous conditionally decreed water rights bearing earlier priority dates on the White River which could be developed and thus preclude use of RBOSP's 1974 decree. Recognizing the need to obtain water rights with earlier priority dates to ensure water supply reliability, RBOSP initiated negotiations with Rocky Mountain Power Company (ROMPOCO), owners of such industrial water rights. Meanwhile, RBOSP filed an application with the Water Court to change the point of diversion of the ROMPOCO decree to a point near Yellow Creek, some 70 miles downstream of the originally decreed diversion points.

8.5 COMMUNICATIONS

Mountain Bell Telephone Company will provide telephone service to Tract C-a, from Rangely. The line serving the tract will be a buried cable installed adjacent to, and wherever possible, within the road right-of-way, thus providing good access for construction and maintenance. Enough circuits will be provided to accommodate interproject, local and long-distance calls. Other services that will be available by virtue of the telephone system include telemetering, telecopying and data transfer.

The line will follow the Rangely access road, but will not be installed until the road is completed. Thus, temporary radio-telephone facilities will be provided to handle communications during the early phases of construction.

CHAPTER 9
ENVIRONMENTAL PROTECTION, HEALTH & SAFETY

9.1 INTRODUCTION

Tract C-a lease stipulations require compliance with all applicable Federal, state and local statutes, regulations and standards relating to water pollution control, water quality, air pollution control, air quality, noise control and land rehabilitation. Further requirements are to avoid, minimize and where practicable, repair damage to the environment.

Rio Blanco Oil Shale Project is approaching the development of Tract C-a with a sincere desire to make its activities as free from environmental damage as is practicable. Toward this end, environmental interfaces have been included in all engineering work. This has permitted the development of designs and selection of equipment, alternatives and techniques that will mitigate or eliminate environmental damage.

The health and safety and environmental protection plans presented have a threefold function:

- To set forth the pollution control devices and techniques planned for the project.
- To serve as guidelines for detailed design and equipment selection.
- To serve as guidelines for construction and operation of the various facilities in a manner to mitigate environmental damage as much as practicable.

The concept of development in phases will permit the evaluation of many of the environmental quality control techniques and equipment on a full-scale basis, with time to refine these plans prior to committing vast amounts of resources for the equipment required to implement Phase II. Planning has been concentrated on Phase I, but the concepts developed are directly applicable to the larger facilities required in Phase II. In instances where Phase II will introduce new problems to the environment, those problems are considered separately.

To cause the least possible impact on water quality, a no-discharge concept will be employed throughout the entire project. In no instance will contaminated water be discharged to the surface or ground water courses. Natural drainages will be diverted around operating areas to avoid contamination.

Rehabilitation, including revegetation, will be a continuing program, commencing in the early years with road and power line corridors. As disposal sites are brought to final configuration, revegetation will progress as closely behind the operation as is practicable.

The environmental control plans, equipment and techniques presented throughout the DDP and in this section, in particular, are based on current knowledge and technology in the field. Actual construction and operation of this project will provide some additional information on materials and processes which will permit changes and improvements to be made in the environmental control activities. Rio Blanco intends to take every opportunity to increase its ability to eliminate, minimize or mitigate any environmental degradation that may result from the oil shale development.

9.2 HEALTH AND SAFETY

The Rio Blanco management intends to have this project designed, constructed and operated in a manner to produce a workplace that is as free as possible of hazards to either workers or the public. To this end, the project management and staff will be fully involved in the project safety effort.

At the completion of final design and prior to the start of construction, a detailed health and safety program for the construction phase will be developed to include the necessary rules and codes to ensure that the facility will be built safely and in full compliance with all applicable regulations. Prior to the start of mining and processing facility operation, a detailed health and safety program will be developed in a similar manner to cover all operations.

The project manager during construction, and one of the top Rio Blanco management personnel during operation, will have full responsibility for executing and implementing a program of employee protection and accident prevention. A safety engineer, responsible to the project manager (construction phase) or top Rio Blanco manager (operation phase) will be employed on the project. He will be charged with inspection and investigation of work methods for safe performance, orientation of new employees in safety practices, organization of safety meetings and supervision of first aid treatment and facilities.

A management safety committee will be formed with at least one member from each major department. The committee will meet monthly to:

- Promulgate and review safety procedures and policies.
- Discuss major accidents, pointing out the causes and how the accidents could have been avoided.
- Discuss safety hazards and suggest methods to control or eliminate them.
- Develop continuing safety programs with emphasis on problem areas.
- Review progress of work on any necessary safety improvement.

Management will be responsible for instructing each employee to recognize and avoid unsafe and hazardous conditions connected with his particular job and be aware of and understand those safety regulations applicable to his working environment.

The projects' safety and health training program will include an initial indoctrination by the safety supervisor, prework briefing and demonstration by individual supervisors, periodic safety training meetings, and follow-up field training and supervision to ensure that safety rules and regulations are fully understood and are being complied with.

In addition to a workplace safety and accident prevention program, a number of special concerns need to be considered. These include exposure of employees to dust or fumes that are potentially harmful, exposure to high noise levels, handling of explosives, exposure to power cables and lines, and use of heavy machinery. Programs will be designed with these special concerns in mind in order to protect the health and safety of employees and the public.

9.3 FIRE PREVENTION AND CONTROL

Fire prevention and control is of particular importance in the project construction, mining and processing activities, due to the unusually large concentrations of explosives, flammable liquids and combustible material in a relatively confined area. A detailed fire prevention and control plan will be developed to include preventive measures, emergency procedures, and training methods. The Rio Blanco management will designate a member of the supervisory staff as the project fire control coordinator to be responsible for the operation of the fire prevention and control plan.

Fire prevention during construction is of particular concern because of the varied, widespread and scattered types of activities and the number of people and equipment items involved. A supply of fire fighting tools and equipment will be furnished to each construction site. In addition, chain-saw crews and dozers working anywhere on the project will be immediately available for fire control within the project area.

Special precautions will be taken during activities such as blasting, welding, storage of gas and oil and storage and handling of explosives to prevent fires. Open burning is not contemplated as a general practice on the project, and any burning will require specific application to and approval of the Area Oil Shale Supervisor.

The fire prevention and control plan for both the Phase I and Phase II processing facility incorporates a four-fold approach:

- Engineering design and plant layout to minimize the likelihood and severity of fire occurrence.
- Training program to instruct all plant personnel in normal plant operation, as well as in fire fighting procedures and details of the fire prevention and control plan.
- Adequate fire fighting equipment available throughout the processing facility for use by trained personnel, together with an effective communication system to coordinate fire fighting efforts.
- Safety program incorporating regularly scheduled inspection of processing facility operating and fire fighting equipment.

All self-propelled mobile equipment will be provided with suitable fire extinguishers. Stockpiles will be located at least 50 feet from all buildings and facilities and accessways (at least 12 feet wide) will be maintained around and between stockpiles to permit access of fire control equipment. Combustible materials, grease, lubricants, or flammable liquids will not be allowed to accumulate in areas where they can create a fire hazard.

A personnel training program will be conducted to provide instruction in safe procedures for normal operation of the facilities, and to provide instruction in the specifics of the fire control plan and use of the fire-fighting equipment. In-plant fire teams will be organized among personnel on duty for each shift and a call-out procedure will be used to obtain additional personnel, if needed. Members of these fire teams will receive intensive, continuous training in actual fire fighting techniques.

9.4 NOISE

Construction and operation of the RBOSP mining, processing and disposal facilities are expected to generate significant amounts of noise. The facilities will be designed and operated to comply with the Tract C-a lease terms and all applicable laws, rules and regulations.

Due to the remote location, the public will not generally be subjected to excessive noise levels. Noise levels will be monitored to ensure that employees are not subject to excessive noise. Noise exposure of workmen will be controlled by the following techniques:

- Limiting exposure time
- Providing individual protective equipment
- Providing sound control enclosures

9.5 AIR QUALITY CONTROL

The Rio Blanco Oil Shale Project recognizes that preservation of the air quality of the Piceance Creek basin is of utmost importance. Every reasonable effort will be made to control fugitive dust, to minimize particulates and gaseous emissions, and to maintain air pollutants at levels below the state and Federal standards. Rio Blanco will use the best available control technolog to control emissions. Soil stabilizers, dust retardants and surfactants, suppression systems, dry-fabric collection designs and high-efficiency wet scrubbers will be employed to maintain the air quality of the Tract C-a area.

A. Control Methods - During construction, dust will be controlled by confining traffic to specified roads and corridors, minimizing land disturbance, watering roads frequently and using dust palliatives. Straw, matting and mulch from existing vegetation will be used when required to hold soil from blowing or washing until revegetation can take place. Open burning of waste, timber, brush or construction debris will be used only as a last resort.

During operations, dust within the mine will be controlled primarily through the use of frequent sprinkling in areas of dust generation. Water injection will be used in drilling blast holes. Haul roads will be continually bladed and watered to maintain a suitable dust-free surface for the heavy haul trucks. A palliative to bind the soil particles together may be used to augment the watering program.

The crushing, conveying and stockpiling of the oil shale ore will generate a major portion of the fugitive dust and particulate emissions from the project. Three basic concepts will be used to control these emissions which are expected to occur at points in the system where transfers are made, e.g., transferring from the end of one belt to another, transferring in a pile or surge bin, or transferring from a crusher to the belt. The first is to completely cover conveyor belts to eliminate particulate emissions caused by wind. Water sprays at selected transfer points to drop the dust back onto the belts is the second, and third, induced-draft fans and baghouse filters will be used at some of the transfer points and the crushing buildings.

The Phase I processing facility is designed to control atmospheric emissions from two major sources:

- fired heaters and boiler stacks
- process stacks

Control of emissions from heaters and boilers is accomplished by using a purified gas to supply the fuel requirements of the facility. Desulfurization is carried out in the sulfur recovery plant where about 98% of the sulfur compounds in the untreated gas are removed. Ammonia, which can form nitrogen oxides in combustion systems, is removed from the gas to the extent of about 99% by contact with water in the raw oil recovery and high BTU gas plants. The use of the purified gas as fuel provides low emissions of trace hydrocarbons and particulate matter since more complete combustion can generally be obtained in heaters and boilers with gaseous fuels than with liquid fuel oils.

The most important process stacks in the Phase I processing facility are located in the TOSCO II retorting plant, specifically the preheat, ball circulation, and shale moisturizing system stacks. The preheat system is fired with purified fuel gas but the flue gas picks up shale dust and trace hydrocarbons as it passes through the system. An incinerator is provided to remove 90-95% of these hydrocarbons by combustion. The flue gas then passes through a high energy venturi scrubber to remove 99.6-99.9% of the entrained dust.

The ball circulation system uses flue gas from a steam superheater fired with purified gas to remove shale dust from ceramic balls. Dust entrained in the flue gas is trapped in a high energy venturi scrubber. The shale moisturizing system generates steam during the process of adding water to processed shale. The vapors are passed through a high energy venturi scrubber to remove entrained shale dust.

Water recovered from the raw oil recovery, thermal cracking, and high BTU gas plants contains dissolved hydrogen sulfide and ammonia. This water is steam stripped and the evolved gases are treated in the sulfur recovery plant to remove about 99.5% of the contained hydrogen sulfide. Ammonia-containing residual gas, spent regeneration air from the sulfur recovery plant, excess fuel gas and API separator sludge are burned in a thermal oxidizer. The ammonia containing gas is handled in a special burner in the oxidizer to minimize formation of NO_x from ammonia.

The design philosophy with regard to emission control for the Phase II processing facility is essentially the same as that used for the Phase I facility. Higher capacity and increased complexity of Phase II processing, however, requires more extensive use of control systems. The concept of supplying plant fuel requirements with purified gas was retained by treating high BTU gas from TOSCO II retorts and low BTU gas from gas combustion retorts in amine and ammoniacal liquor scrubbing systems. Removal of sulfur compounds from both gases is about 98%; ammonia removal is about 99%. Purified high BTU gas and C_4s are used as fuel for process heaters and boilers; a mixture of purified high BTU and low BTU gas is used as fuel for the TOSCO II retorts.

The important process stacks in the Phase II processing facility are located in the retorting, sulfur recovery and hydrogen plants. Flue gases from the TOSCO II retorting plant are treated as described for the Phase I facility. Vapors from the shale moisturizing system in the gas combustion retorting plant are passed through a high energy venturi scrubber to remove entrained shale dust.

Water recovered from the raw oil recovery, delayed coking, hydrogen, hydrotreating and gas plants is sent to the ammonia recovery plant. Dissolved hydrogen sulfide and ammonia are removed from the water and the ammonia is recovered as a liquid by-product. Hydrogen sulfide-containing gases from the ammonia recovery and hydrogen plants are sent to the sulfur recovery plant where about 99.5% of the contained sulfur is removed and converted to elemental sulfur by-product.

Carbon dioxide produced as a by-product in the hydrogen plant is vented to the atmosphere. The carbon dioxide stream is scrubbed prior to venting to reduce the total contained sulfur compounds to a level of about 5 ppm hydrogen sulfide and 20 ppm carbonyl sulfide.

Hydrocarbon emissions from storage tanks in the Phase I and Phase II processing facilities are controlled by using floating roof tanks where appropriate for the more volatile liquids.

Particulate control in the processed shale and overburden disposal area will be by:

- frequent sprinkling of haul roads
- compaction of processed shale and overburden as it is distributed
- maintaining proper moisture content, while the material is being hauled, deposited, compacted, shaped and revegetated
- avoidance of inactive disposal areas by vehicular traffic
- establishment of vegetation (temporary and permanent) as soon as possible
- use of dust suppression systems at transfer points and stacking booms (during Phase II)

Fugitive dust and particulate emission control techniques for the construction and erection of the support facilities will be similar to those described earlier for the construction of the mine and processing facility. The support facilities will include office buildings, shops, a water control dam, process water reservoir, water, oil and sewage pipelines, electric transmission lines and power distribution facilities. Minimizing land disturbance, frequent watering and prompt revegetation are the key techniques for dust control for both Phase I and Phase II.

B. Modeling - Based on the estimates of gaseous and particulate emissions from the project, an atmospheric dispersion model was used to predict concentrations of these pollutants on and around Tract C-a. The first full year of lower air baseline measurements and analysis were used as the modeling data base. Model calculations based upon inversion intensities and depths (mixing layer data) were made using the data acquired from the seasonal upper air studies.

The air pollution dispersion model used is a well established mathematical technique which takes into account physical considerations of the plant orientation and configurations with respect to surrounding terrain features. For this type of dispersion estimate, the best attainable accuracy, in the absence of confirming measurements of air quality, is approximately ±15%. This accuracy is realized for near-ideal conditions, that is, continuous emissions, flat ground surface, and steady winds throughout the time period of interest. Best accuracy is obtained for distances between 100 and 2000 meters and for averaging intervals in excess of 30 days.

In order to preserve a margin of safety in analyses, conservative estimates were favored in developing the model. As a result, adverse environmental impacts will tend to be overstated.

The computer simulation analyses performed to assess the air quality impact of the proposed project was made using two different but related techniques. These were for long term evaluations (annual periods) and short term evaluations (3-hour and 24-hour periods). Both the long and short term evaluations are based on the univariate Gaussian equation.

Estimates of maximum predicted concentrations of sulfur dioxide (SO_2), nitrogen oxides (NO_x), non-methane hydrocarbons (NMHC) and particulates were made by use of the dispersion model for Phase I - Stage 2 and Phase II periods. The modeling

Table 2-9-1

COMPARISON OF MODELING RESULTS WITH APPLICABLE STANDARDS FOR PHASE I - STAGE 2 OPERATIONS

Applicable Standard	Emission	Averaging Time	Standard Limit (µg/m^3)	Maximum Predicted Off-Site Increment Due to Development (µg/m^3)	Predicted Off-Site Value (µg/m^3)
State - Category I					
Max. allowable Increment	SO_2	Annual	3	1	NA
		24-hour	15	14	NA
		3-hour	75	82†	NA
Federal - Class II					
Max. allowable Increment	SO_2	Annual	15	1	NA
		24-hour	100	14	NA
		3-hour	700	82	NA
	Particulates	Annual*	10*	4**	NA
		24-hour	30	22	NA
Colorado Ambient Air Quality Standard	Particulates	Annual	45	4	23
		24-hour	150	22	41
National Ambient Air Quality Standards					
Primary	SO_2	Annual	80	1	10
		24-hour	365	14	23
Secondary	SO_2	3-hour	1300	82	91
Primary	NO_2	Annual	100	14	16
Primary	Particulates	Annual	75	4**	16
		24-hour	260*	22	34
Secondary	"	Annual	60	4**	16
		24-hour	150	22	34
Primary	NMHC	3-hour (6-9 AM)	160	156	221†

* Geometric Mean

** Arithmetic Average

NA - Not Applicable

† See text for clarification

analysis predicts that Phase I - Stage 2 operations will meet present applicable ambient air and significant deterioration standards set by both EPA and the state of Colorado except for the Federal non-methane hydrocarbon standard and the present Colorado Category I 3-hour SO_2 standard. These standards will be met during Phase I - Stage 1 operations. Based on data gathered during Stage 1, an engineering design will be developed for Stage 2 which will result in acceptable non-methane hydrocarbon levels. All Colorado Category II Standards for SO_2 will be met during Phase I - Stage 2 operations. A summary comparison of modeling results with standards for Phase I - Stage 2 operation is given in Table 2-9-1.

The modeling predicts that Phase II operations will meet all applicable Federal ambient air quality and significant deterioration standards. In addition, the particulate loading produced by the Phase II operations will meet Colorado standards. Within the present classification of the Piceance Creek basin as Category I, the modeling predicts that the proposed Phase II operations will not meet the current short-term ambient SO_2 standards set by the state of Colorado. The operations, however, will meet all applicable standards should the area be redesignated as Category II by the state.

Table 2-9-2 is a comparison of modeling results with applicable state and Federal standards for Phase II operations. Note that state Category II standards are used in the comparison.

9.6 WATER QUALITY CONTROL

The water quality control plan to be employed in developing Tract C-a is illustrated schematically in Figure 2-9-1. The system is an adaptation of the American Petroleum Institute's zero discharge water concept. In RBOSP's case, all water is planned to be consumptively used, either through evaporation to the atmosphere or by absorption in the processed shale disposal pile where it will be an aid to achieving optimum compaction.

Table 2-5-2

COMPARISON OF MODELING RESULTS WITH APPLICABLE STANDARDS FOR PHASE II OPERATIONS

Applicable Standard	Emission	Averaging Time	Standard Limit ($\mu g/m^3$)	Maximum Predicted Off-Site Increment Due to Development ($\mu g/m^3$)	Predicted Off-Site Value ($\mu g/m^3$)
State - Category II					
Max. allowable Increment	SO_2	Annual	15	2	NA
		24-hour	100	19	NA
		3-hour	700	94	NA
Federal - Class II					
Max. allowable Increment	SO_2	Annual	15	2	NA
		24-hour	100	19	NA
		3-hour	700	94	NA
	Particulates	Annual*	10	10	NA
		24-hour	30	29	NA
Colorado Ambient Air Quality Standard	Particulates	Annual**	45	10	29
		24-hour	150	29	48
National Ambient Air Quality Standards					
Primary	SO_2	Annual*	80	2	11
		24-hour	365	19	28
Secondary	SO_2	3-hour	1300	94	103
Primary	NO_2	Annual*	100	8	10
Primary	Particulates	Annual*	75	10**	22
		24-hour	260	29	41
Secondary	"	Annual*	60	10**	22
		24-hour	150	29	41
Primary	NMHC	3-hour (6-9 AM)	160	64	129

* Geometric Mean
** Arithmetic Average
NA - Not Applicable

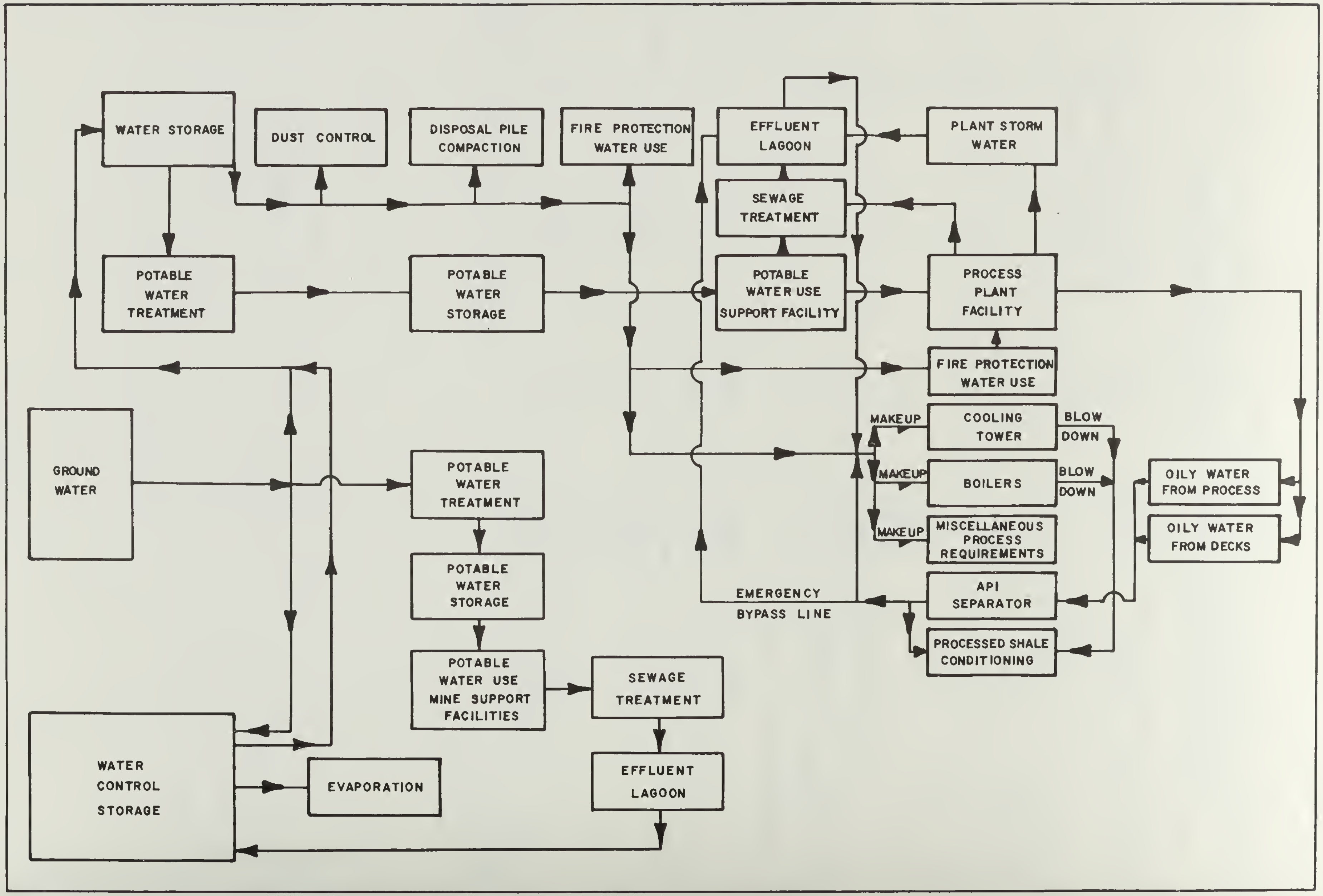


Figure 2-5-1

RBOSP WATER QUALITY CONTROL SYSTEM

The system will be designed to control surface runoff water as well as mine and processing waste waters. Surface water originating outside the Tract C-a project area will be diverted around RBOSP facilities. Surface water originating within the project area will be controlled by a series of ditches and retention dams and either recycled to RBOSP's water supply system or allowed to evaporate.

From a water control standpoint, RBOSP's processing facility will be closely akin to typical U.S. refineries. Refinery operators are now quite experienced in controlling water quality, and application of the zero discharge concept in a shale oil processing facility will be a relatively small step from conventional refinery practice. The other principal source of water effluent from the Rio Blanco Oil Shale complex is the mine. In this respect, however, RBOSP will be able to not only control mine water but to put it to beneficial use as well. Water developed in the mine dewatering operation will be of sufficient quality to permit its use in all project activities. Some water will be treated to provide potable water supplies where needed, but most of the ground water from beneath Tract C-a will be used as is.

Current information indicates that ground water from mine dewatering must be supplemented during Phase I and the early years of Phase II by additional ground water wells to meet RBOSP demands. All mine water produced during this period will thus become part of the project's water supply and be completely controlled by virtue of the zero discharge water handling system. Beginning about the eighth or ninth year of Phase II, mine dewatering is expected to exceed project needs but exact quantities are difficult to predict at this time.

After mining begins, mine dewatering operations must continue essentially uninterrupted whether the processing facility is operating or not. Before the time when mine water is expected to exceed project demand, a small water collection pond will be provided near the processing facility. It will be used to store water from dewatering operations when the processing facility is either shut down or operating at reduced capacity; the supplementary water wells expected to be needed during this time can also be used to regulate water production.

When water from dewatering operations begins to exceed project demand, a larger water control reservoir located about three miles east of the tract in Corral Gulch will be used to store excess mine water. As now planned the Corral Gulch reservoir will not be constructed until after Phase II begins.

Despite the ground water information developed to date by RBOSP, actual mine dewatering requirements will not be known until mining operations begin. Thus, the possibility does exist that mine water production could exceed RBOSP demand earlier than expected. This possibility is viewed as remote, but in the event the excess mine water is encountered earlier than expected, RBOSP will consider two alternatives for handling the water: (1) the excess water will be used to augment flow in area streams, or (2) the Corral Gulch water control reservoir will be built earlier than now planned and will be used to store the excess water.

If shale oil production is increased beyond the Phase II level of 55,800 BPSD, a surface water supply will have to be developed to supplement Tract C-a ground water resources. Should this occur, however, it will not change the modified zero water discharge plan; part of the water supply will merely be coming from a different source.

9.7 OIL AND HAZARDOUS MATERIAL CONTROL

The oil and hazardous material control plan has been formulated recognizing that the best control plan is prevention of spills through proper design of storage, handling and transporting facilities. However, a spill contingency plan will be implemented during all phases of the project, establishing procedures to be followed to minimize damages in the event of accidental spills.

This spill contingency plan includes procedures for notification, containment, repair and cleanup of spills. The primary objective is to minimize, as far as practicable, any damage from a spill to persons, property, flora and fauna.

The layout and construction of tanks, valves, piping and appurtenances will be designed to minimize the possibility of spillage. Tanks will be enclosed by dikes designed to form spill-containment basins. The drainage from these diked areas will enter the processing facility storm drainage system and pass through an API oil separator. Catchments will be constructed in any natural drainageways immediately downhill from the oil storage facilities so that should any oil find its way outside containment facilities, it can easily be controlled before it reaches a water course.

A detailed spill contingency plan will be developed for both nontransportation and transportation-related facilities. This plan will include procedures in the event of a spill for discovery and system shutdown, notification, reporting to Federal and state agencies, internal reporting, containment of the spill, removal of spilled material, and cleanup and restoration of the contaminated site.

9.8 LAND REHABILITATION AND EROSION CONTROL

The objectives of the land rehabilitation program are to reclaim disturbed areas by returning them to a state that does not contribute to environmental deterioration and is consistent with surrounding aesthetic values. The overall concept of rehabilitation efforts for the project includes numerous problems and considerations dealing with mining, access, plant sites, parking lots, conveyor corridors, access roads, pipelines, etc. The principal elements considered are site preparation, erosion control and revegetation.

Table 2-9-3 shows estimates of the yearly disturbed surface areas and areas ready for rehabilitation for the Phase I and Phase II operations. The Rangely access road, power line and telephone line are excluded because they will be constructed and rehabilitated by other entities, i.e. Rio Blanco County, Moon Lake Electric and Mountain Bell.

Site preparation, or the shaping and grading of areas being rehabilitated, is controlled by three primary environmental concerns: erosion control, aesthetics and type of flora to be supported. One additional factor influencing the

Table 2-9-3

ESTIMATED ACREAGES DISTURBED AND REHABILITATED DURING PHASE I AND II*

	Disturbed										
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986-2015	Total
Open Pit Mine and Facilities	25	50	30	5	15	15				630	770
Processing Facility	100			15		135					250
Processed Shale and Overburden Disposal Area		110	60	25	30	55	35	60	25	3,650	4,050
Support Facilities Internal Roads, Conveyors and Power Distribution Lines	65	110							50		225
Product Pipeline		60									60
Water Control Facilities		100	25	15						260	400
Total	190	430	115	60	45	205	35	60	75	4,540	5,755

	Rehabilitated									
	1978	1979	1980	1981	1982	1983	1984	1985	1986-2015	Total
Processed Shale and Overburden Disposal Area	45	50	25	30	35	35	35	50	3,745	4,050
Support Facilities Internal Roads, Conveyors and Power Distribution Lines	30		50						25	105
Product Pipeline	60									60
Water Control Facilities	55	25	15							95
Total	190	75	90	30	35	35	35	50	3,770	4,310

*Includes 30 years at Phase II production rate but assumes operation continues after 2015 so many of the affected areas are not shown as rehabilitated.

rehabilitation work is the chosen method of constructing an artificial soil profile on the processed shale and overburden disposal piles to facilitate revegetation.

Topsoil excavated for roadway construction operations will be stockpiled in selected areas along the alignment for reuse to cover cut-and-fill slopes. Soils excavated from the mine area will be stockpiled for later reuse to cover processed shale or overburden and to rehabilitate the mine. The topsoil and subsoil in the disposal area will also be excavated and stockpiled separately in an area where it can be reused later.

In the processed shale and overburden disposal areas, the initial stripping will be on only about 40 acres. This material will be stockpiled and used as required. At that time, nutrients will probably be added in order to restore fertility in the soil. Additional stripped material will be transported directly onto the overburden and processed shale piles as they reach final configuration, thereby eliminating the loss of biological and organic matter inherent in any long term stockpiling process.

Special treatments will be applied to the surface of the processed shale disposal pile because the soluble salts in the processed shale, if uninhibited, may migrate by capillary action to the surface during the summer months. Continuous maintenance activity in the form of leaching and irrigation would be required to revegetate processed shale with only the addition of the small amount of soil available.

To avoid the necessity for extensive leaching of salts from the surface of the processed shale, an artificial soil profile will be developed. This artificial soil profile will consist of a layer of rock to stop capillary movements of moisture from the processed shale upward toward the root zone. The rock will be covered with subsoil and topsoil. Upward moisture migration in the liquid phase is not anticipated across the rock layer. However, the rock layer will not interfere with the movement of small amounts of moisture in the vapor phase, and additionally will prevent soluble salts from migrating toward the surface.

The thickness of the soil will be determined prior to construction in order that sufficient material will be available to cover the entire surface of processed shale and overburden. The quantities of soil are being determined by a soil survey currently in progress. Topsoil will be placed on top of the subsoil. The quantities are yet to be determined, but it is anticipated that 6 to 10 inches of topsoil will be available.

One major problem in developing an artificial soil profile on top of the processed shale is retention of sufficient soil moisture to provide for the year's growth of vegetation. It is expected that the soil profile underlain by the rock layer will have a higher field moisture capacity than one placed directly on the processed shale. Normally, in natural soil profiles, a topsoil underlain by a sand layer has a higher field capacity than the same soil without the underlying sand layer. The underlying processed shale may alter water retention characteristics in the soil profile enough to cause some deviations.

Slope roughening practices, such as scarification and serrated slopes, will be used to decrease runoff, as well as to slow the water movement. These practices reduce the ability of moving water to detach soil particles and transport sediments. Some of the proposed practices include:

- Slope roughening by scarification along the contour of a graded slope. The grooves spread the runoff horizontally, slow its movement downslope and increase the infiltration rate. Roughening is also beneficial in the establishment of vegetation on a graded area. The horizontal grooves retain soil additives, seeds and mulch that might otherwise be washed down the slope. This practice also increases moisture retention and loosens the soil in the plants' root zone.
- Operating a bulldozer up and down a graded slope. This practice is referred to as "tracking" and is more adaptable to steep slopes than scarification. Tracking does not loosen the soil as much as scarification, and the resulting compacted soil may be more effective on long or steep slopes exposed to high intensity rainfall.
- Pockets developed on slopes at varying intervals.

Selective spreading of individual large rocks may be included in this treatment to provide energy dissipation and shade for new plants, and to break up regular structural lines and improve the appearance.

Facilities will be provided to drain interception ditches and benches, and to direct the flow of water into erosion resistant areas or into specially designed channels. As required, a number of special disposal structures will be used including drain pipes, down drains, chutes and flumes. These disposal structures will be designed to handle the water and sediments that occur as a result of an unusually heavy downpour on bare soil areas. They will be designed for both permanent and temporary use.

Water bars and breaks will be constructed to divert water from unsurfaced roadways into natural drainages. To keep flows in road ditch sections from reaching dangerous proportions, cross drains will be installed in addition to regular drains.

Seeding and planting operations are restricted seasonally and slopes constructed between seasons will be quite vulnerable to erosion.

Temporary erosion control measures will be provided as required at all sites where grading has been done and revegetation has not been completed. Shielding and/or protecting the soil can be accomplished in different ways. A wide variety of products is available commercially, and some materials can be found locally.

Choosing the best cover material is a matter of convenience, cost, ultimate purpose and effectiveness. When the cover material is applied as an initial step in revegetation, it should also have good mulching characteristics. Some of the materials that are being considered for this project, their application rates and special conditions are listed below:

- Straw (2 tons per acre) - Straw is versatile, effective, easily obtained, but is susceptible to wind damage.

- Emulsions (500 to 800 gallons per acre) - Emulsions provide a quick, effective cover and are normally effective in wind. It is often combined with straw to provide good ground cover.
- Chemical binders - Various sprays of dust stabilizing agents or glue-like substances can be used. These binders generally penetrate into the surface of the soil before they set, combining with individual soil grains to form a mat.
- Cellulose fibers (1 ton per acre) - Cellulose fibers can be applied using hydroseeding techniques.
- Jute netting and mats - Jute netting and mats are temporary but quick and easy to apply as a good, instant ground cover.
- Plastic matting and nets - Normally they give an excellent lasting cover and the vegetation will normally grow through the material openings.

RBOSP will initiate a reclamation program to reclaim all areas disturbed by mining operations in the vicinity of Tract C-a in accordance with lease stipulations. The processed shale and overburden disposal piles represent the most difficult revegetation task since they exhibit chemical and physical properties foreign to the surrounding area. These areas will require greater effort to achieve successful revegetation. The available technology appropriate for revegetation on Tract C-a seems sufficient to insure the likelihood of successful revegetation in all disturbed areas. Aspects of technology considered include: oil shale characteristics, seedbed prepartion, seeding, mulch, fertilizer, biotic influences, management and revegetation schedule.

In addition, RBOSP has initiated an experimental revegetation program to investigate problems specific to revegetating disposal piles on Tract C-a. This three-year program consists of three successive fall plantings beginning in the fall of 1975. Two sites (approximately two and one-half acres each) were planted in 1975 and one additional site is scheduled during 1976 and 1977. The 1975 plantings were carried out on a soil substrate disturbed to a 3-ft depth to simulate the artificial soil profile proposed for the disposal piles. If feasible in 1976 or 1977, this disturbed 3-ft soil profile will be underlain by processed shale. These studies are investigating: the plant species best adapted to the environmental conditions existing in the Piceance Creek basin when sown in a composite mixture; optimum period for fertilization; most effective mulch for plant establishment and erosion control; and effect of aspect on revegetation success. Plant response will be measured by quantitative parameters which include density, biomass, and percent cover. These data will allow statistical analyses to determine the effects of the applied treatments.

The revegetation experimental program represents the initial step in the formulation of a successful revegetation plan for RBOSP Tract C-a. The experimental results will provide a specific data base from which to evaluate and modify current methodology to further insure successful revegetation on Tract C-a.

9.9 SOLID WASTE CONTROL

The solid waste control plan has been developed for the disposal of solid wastes, excluding processed shale and overburden, which are produced during both the construction and operation phases of the project. These solid wastes include process-(catalysts and water treatment chemicals) and nonprocess-(paper, wood, metal, etc.) related waste.

To the extent possible an effort will be made to recycle nonprocess solid wastes. Nonrecyclable waste will be collected and transported to an approved sanitary landfill. Present planning contemplates that the solid waste disposal operation will be conducted at the same location as the processed shale disposal operations. When processed shale disposal commences, the solid waste disposal trenches will be constructed within the compacted processed shale. This method will minimize the land disturbed for the actual disposal, eliminate the need for construction and maintenance of separate access roads and storm diversion facilities, and require less equipment, fuel and manpower.

The principal solid wastes (other than processed shale) produced in the Phase I - Stage 1 processing facility are approximately 600 pounds per year of spent zeolite water softening resins and 60 pounds per hour of lime sludge from the water treatment system. The lime sludge and spent zeolites will be disposed of with the processed shale. No adverse environmental effects are expected since the lime sludge and zeolites are very stable and comprise a very small fraction of the total material disposed of in the processed shale and overburden pile.

In addition to lime sludge and spent zeolites from the water treatment system, the Phase II processing facility will generate a certain amount of spent catalysts from hydrotreating, sulfur and hydrogen plants. Spent zeolites and lime sludge will be disposed of in the processed shale and overburden disposal piles. Because they are quite stable no adverse environmental effects are expected. To the extent possible, the spent catalysts will be recycled. Preliminary information from vendors indicate that all catalysts, with the exception of the proprietary catalysts used in the naphtha and gas oil hydrotreaters, can be recycled.

The licensor for the hydrotreating processes indicates that the spent catalyst could be disposed of in the processed shale and overburden disposal piles without harmful environmental effects, but supporting data is not yet available. Therefore, present plans are to store the spent hydrotreating catalysts in impermeable, lined bunkers near the processing facility until the leaching effects of the catalyst are further studied and a suitable technique for permanent disposal can be devised.

9.10 AESTHETICS

The principal aesthetic value of Tract C-a and its evirons is the landscape, which is characterized by rolling hills and flat-topped ridges with steep to moderately sloping canyon walls dropping 100 to 300 feet into narrow, flat-bottomed valleys. Aesthetic values were considered in planning the facilities and operations; however, aesthetic guidelines could not always prevail because of economic constraints and conflicting environmental requirements.

9.11 FISH AND WILDLIFE MANAGEMENT

The fish and wildlife management plan presents RBOSP's plans to: avoid, or where avoidance is impracticable, minimize damage to wildlife habitat; increase production on adjacent habitats to compensate for habitat unavoidably destroyed or damaged; monitor known and possibly unknown effects of oil shale development and the effects of mitigative procedures and habitat enhancement procedures; and control employee or contractor-caused human disturbance.

This plan was designed within the legal constraints of RBOSP authority and jurisdiction. Even so, totally effective implementation of this plan will require efforts outside the tract boundaries. Therefore, legal constraints beyond the control of RBOSP could hinder the effectiveness of the plan. For example, the use of deer habitat enhancement areas by off-road vehicles such as snow machines could render such enhancement completely ineffective. Yet the lease specifically prohibits the lessee from imposing the kind of regulations needed to control such activities. In general, this fish and wildlife management plan will achieve maximum effectiveness only if it is applied beyond the present limits of RBOSP authority by the appropriate state and Federal agencies.

Wildlife management concerns outside of the lease area are under the jurisdiction of agencies such as the Colorado Division of Wildlife and Bureau of Land Management. Rio Blanco Oil Shale Project will cooperate wherever possible with these agencies in fulfilling the objectives of the Habitat Management Plans for the Piceance Creek basin now in the development stage. This wildlife management plan is designed to protect wildlife values to the fullest extent possible. In doing so, two key goals of the prototype oil shale leasing program will be fulfilled. These are: (1) protecting the environmental integrity of the oil shale areas; and (2) learning the environmental costs of oil shale development.

This plan will, as much as possible, address the ecosystem as a whole in an attempt to approach problem solutions in a unified, systematic effort. However, primary emphasis must necessarily be on those species of economic importance, endangered or threatened status, ecological importance, rarity, or high aesthetic value. This plan was formulated after careful consideration of data collected during the first year of baseline studies and data available from other sources.

Habitat enhancement is discussed as a means of mitigating impacts or effects of habitat reduction due to development. However, many complicating factors are involved in this approach. Habitat manipulations must be carefully approached to prevent a counterproductive result. Also, the jurisdiction of RBOSP is limited and lease stipulations address enhancement measures. With these factors in mind, the following steps toward habitat enhancement are discussed.

Wildlife habitats will be manipulated in an attempt to increase productivity, and hence carrying capacity of lands adjacent to those areas to be rendered unproductive in a two-step approach.

Initial land disturbance associated with Phase I and transition phase operations will be far less in total acreage as compared to the proposed Phase II operations plans. Thus RBOSP can, within its legal limits, utilize and enhance existing lands on Tract C-a in the early phases of development. This plan will not interfere with existing mining plans which place the open pit in the northwest corner of the tract progressing in a southeastern direction. When the extent of mine land disturbance outstrips available enhancement land on Tract C-a, this will necessitate a move into off-tract areas. Prior to this changeover, RBOSP, in cooperation with the land owner and AOSO, will satisfy all legal obligations necessary to the transaction. Such an approach will provide compliance by RBOSP with a lease stipualtion regarding habitat loss and resulting enhancement. In addition, backfilling and subsequent revegetaion will provide additional habitat.

Pinyon-juniper will be modified through very selective chaining to open dense canopies and create zones of vegetation transition in order to increase productivity and wildlife diversity. Slash and woody debris will be occasionally used in the construction of brush piles to improve structural habitat for cottontails and other wildlife.

Discrete areas of bottomland sagebrush will be removed by railing and roto-beating to increase forage production for livestock. Deer may also use the treated areas. Certain limited areas of dense upland sagebrush will be modified as well. A roto-beater will thin specific sagebrush stands by cutting narrow, irregular swaths. Again, the intent is to increase production and diversity.

Runoff collectors (guzzlers) will be installed to provide a permanent supply of drinking water for wildlife. Considerations will be given for other surface water developments, including piping water for livestock.

Perhaps one of the most serious potential impacts to wildlife is the secondary effect of increased human activity in the development area. To help protect wildlife, and reduce the magnitude of this impact, human activity will be regulated within the limits of RBOSP responsibility and legal jurisdiction. Various categories of human disturbance problems are: (1) vehicle-animal collisions, (2) legal wildlife harvest, (3) illegal wildlife harvest, (4) off-road vehicle use, and (5) harassment by humans and companion animals.

Planned mitigation for the above human disturbance problems include reducing speed limits, fencing, posting of hunting laws, education programs for employees, prohibition of off-road vehicle use by RBOSP employees during working hours, and restricting employees from allowing pets to run at large.

This plan must be viewed as a dynamic strategy for reducing negative impacts of oil shale development on the wildlife of the Tract C-a area. As the prototype oil shale development advances, a more effective management strategy will be derived from ongoing specific experiences. The Area Oil Shale Supervisor will be notified of changes to existing plans before their implementation.

9.12 PROTECTION OF OBJECTS OF HISTORIC AND SCIENTIFIC INTEREST

Baseline studies have been conducted to determine if the project area is an area of significant archaeological, paleontological or historic interest. These studies indicate little likelihood that development operations by Rio

Blanco will disturb objects of historic or scientific interest. Just because nothing significant was found does not eliminate all possibility that some important materials do exist. RBOSP will take measures to protect any object of historic or scientific interest that may be found during development, as required by the Federal Antiquities Act.

During development operations RBOSP will avoid, where practicable, archaeological sites identified in the baseline program. Primary sites will be excavated prior to disturbance by development operations, and further study will be made of secondary and tertiary sites before, or during, disturbance if they fall within areas affected by development operations.

No significant paleontologic finds have been observed on the surface on or around Tract C-a. A review of tract core hole lithologic description logs disclosed the presence of sparse small fish remains in three core holes; however, these remains are not unique to Tract C-a. A literature review was also conducted but nothing significant was found.

Based on these studies, the possibility of discovering a significant paleontologic find is considered extremely remote; however, in the event of such an occurrence, RBOSP will take measures to protect the find.

Recent historic material is largely that left by deer hunters. No significant finds have been identified in the project area, but in the event one is identified, RBOSP will take measures to protect and preserve the find.

The primary concern is to avoid damaging historic or scientific material. Operating personnel will be briefed on the archaeological, paleontological and historic resources of the area and instructed to avoid areas of significance. They will be provided with enough information to recognize the presence of historic and scientific resource material, particularly that which is subsurface. In the event potentially significant historic or scientific resource material is unearthed, work will stop in the immediate area until the find is cleared.

In the event of a significant find during project development operations, notice of such findings will be sent to the Area Oil Shale Supervisor, Bureau of Land Management and the State Archaeologist in compliance with lease stipulations and the Antiquities Act.

9.13 ABANDONMENT

Disposition of project facilities when operations cease will be influenced by a number of considerations, including:

- Profitability of oil shale operations.
- State of the art in oil shale retorting.
- Usefulness of the facilities to adjacent operations.
- Degree of government participation and/or control in the shale oil industry.
- Degree of project development.

Because of the wide variety of possible abandonment schemes, it is not possible to propose a definite plan of action at this time. Detailed abandonment plans and procedures will be prepared prior to abandonment activities. Of course, if the facilities should be sold by Rio Blanco as an operating facility, the demolition, salvage and rehabilitation activities would not take place. Also, for a period of six months after termination of the lease, the lessor has the right to purchase at the appraised value any or all items on the lease required or useful for the protection of the leased lands.

Design of the abandonment activities will be governed by the various environmental protection plan concepts. The objective will be to return the site to a stable ecological (not requiring further maintenance) state that will not contribute to continuing environmental deterioration and that will be consistent with the appearance of the surrounding area. All required monitoring programs will continue until the AOSS has determined to his satisfaction that environmental conditions have been established after termination of the development operations which are consistent with the requirements of applicable Federal and state statutes and regulations; however, the AOSS may terminate this requirement at an earlier date when it is in the public interest.

In accordance with the various regulations and lease terms governing abandonment, Rio Blanco would undertake an abandonment plan for the Phase I open pit which would have the key elements shown below. This abandonment plan appears reasonable based on current data, although it is presented as only one of several possible alternative plans for abandonment:

- Revegetate the exposed open pit benches.
- Allow the pit to fill gradually with water.
- Create a reasonably acceptable habitat for wildlife.
- Remove mine buildings and facilities or convey them to the government as described above.
- Reclaim surface area disturbed by mining activities, required by Section 11 of the environmental stipulations to the lease, to a state not requiring further maintenance.

By the end of Phase II, the pit will have extended over a surface area of about 750 acres and to a depth of about 1800 feet. Although it would have significantly increased in size and depth compared to Phase I, only limited backfilling could occur during the 30 years of Phase II production due to the operational requirements of open pit mining. Without pit backfilling as a viable alternative, the following scheme is presented as one possible alternativ plan for abandonment:

- Revegetate the exposed open pit benches.
- Reclaim and revegetate disturbed surface areas, required under Section 11 of the Environmental Stipualtions to the lease, to a state not requiring further maintenance.

Ground water inflow and surface runoff into the Phase II pit should very slowly form a lake in the bottom of the pit. After perhaps thirty years, based on cursory examinations, the water would have reached about to the top of the lower aquifer. Most of the water in this lake would have come from the lower oil shale aquifer and it appears reasonable to expect that water quality would be closer to the quality of that aquifer. Contingent upon the results of experimental introduction of flora and fauna, it is anticipated that life forms presently existent in the lower reaches of Yellow Creek could be introduced to the lake; however, this is greatly dependent upon the dissolved solids content of the lake formed.

RBOSP would actively seek a feasible means of reducing to acceptable minimums the inflows of water from the upper aquifer into the pit, along with its running down the pit walls and mixing with the lower aquifer water. It is believed that there is a reasonable probability that this could be achieved; however, should this not prove to be the case, the commingling of water from the upper aquifer would take place in the lake at a ratio of about 25% of upper aquifer water to 75% of lower aquifer water. Dewatering of the upper aquifer would also continue. Water quality in the pit can be expected to remain about as indicated by the 25%-75% mixture, since annual inflows due to precipitation are estimated to substantially offset evaporation losses.

It is believed that a conceptual abandonment plan for an ultimate pit (total tract) operation should assume waste backfilling against two or more pit slopes along the tract boundary, covering any resource in those areas. Thereby, at the end of total tract development, waste backfilling, (which began after about 30 years) would have reclaimed all of the pit except an area large enough to permit final mining, crushing and conveying operations. This area would probably be on the order of 1,000 surface acres in the southeastern corner of the tract.

The backfilled area of the ultimate pit would be contoured and covered with topdressing to control erosion, permit easy seeding, and present an aesthetically acceptable shape. The surface area and pit remaining after backfilling would be allowed to fill slowly with water and would be revegetated similar to the ideas presented for the Phase I abandonment plan. This should in time provide a reasonable habitat for wildlife in the area.

Abandonment of the processing facility will involve several stages.

- All tanks, aboveground steel and wood structures and aboveground piping will be salvaged and removed. Minimum maintenance shops and administration facilities will remain until the final stages near completion.
- All concrete structures will be demolished down to grade level, and all concrete and asphalt surfacing, curbs, etc., will be broken up in place. Hard packed, unsurfaced or temporarily surfaced roads will be scarified and the tight surface broken up.
- Underground piping, culverts and drains will be plugged and abandoned in place. After the connection pipes have been plugged, catch basins and manholes will be filled with earth.
- All concrete foundations, pavements and other manmade features reduced to rubble at grade will be covered with earth. Most of the cover material can be salvaged from dikes and fill areas and, if necessary, excavated within the already-distrubed areas.
- All graded areas will be recontoured through slope rounding, cutting, filling and other earthwork similar to the techniques discussed in 9.8. Dikes will be removed, ponds and ditches filled or reshaped, and the land generally restored to a natural appearance. The area will then be revegetated in accordance with the principles established for revegetation in 9.8. All these activities will be designed to control erosion and to leave the site in a condition not requiring further maintenance.

Final abandonment activities for the processed shale and overburden disposal area will include:

- Completion of revegetation and removal of irrigation facilities and temporary fencing.
- Obliteration of access roads (roads which will not be left for public use) and revegetation of the last remaining disturbed areas.
- Reshaping and revegetation of abandoned ponds, ditches or dikes.
- Creation of a condition not requiring further maintenance.

Phase II operation envisions the use of conveyors to transport the waste material to the disposal site. The first stage of abandonment in Phase II will be the dismantling, salvage and removal of these conveyors. Reshaping and revegetation of service roads and conveyor routes will proceed simultaneously with the final revegetation activities on the disposal site.

Abandonment of support facilities will follow the same stages as discussed for the processing facility. If desired, some features such as the following may be left in place for other uses:

- Clean-water impoundments
- Selected roadways
- Selected pipelines and power lines

Determination of the facilities to remain, if any, should be made at the outset of detailed planning of the abandonment activities to ensure that some desired facility is not inadvertently destroyed.

Abandonment plans will include the filling and packing of any ditches and the leveling of water diversion dikes associated with oil shale activities which do not contain check dams or other flow inhibitors. The filling in of these ditches and leveling of dikes will result in a great reduction, if not elimination, of gully erosion resulting from oil shale development. Existing reservoirs remaining after abandonment will be allowed to silt in, will again serve as a control against the flow rate in the area, and also will repair a small portion of the area already damaged by gully erosion.

Water quality control ponds such as those downstream from the processed shale disposal site will be allowed to silt in. In the event that a high concentration of soluble salts exist in the ponds a disposal or protection plan will be developed for approval by the AOSS.

A second alternative would be, upon abandonment, to release the reservoir to the proper Federal administrative agency. After the proper Federal agency has assumed administration of the reservoir they may develop a plan for the best use at that time.

CHAPTER 10
ASSESSMENT

10.1 INTRODUCTION

An assessment of environmental impacts is made to determine the effects (both beneficial and harmful) of development on the environment and the living organisms dependent upon that environment within the area proposed for development. Concomitant with describing impacts of development is the responsibility to suggest viable means of lessening or mitigating harmful impacts. Sectors of the environment which will be affected by oil shale development on Tract C-a include air quality, surface and sub-surface water supplies (hydrology), the aquatic environment, and the terrestrial environment.

Assessment of environmental impacts for each of these areas is accomplished by identifying the source of the impact, then discussing the nature, severity, and longevity of the impact. Appropriate mitigation measures are suggested for harmful impacts, and their predicted effectiveness is described. The net harm to the environment after mitigation is described as negative unavoidable impacts.

Since the proposed development is a long-range program, during which periods of impact will vary considerably both in nature and extent, the assessment is partitioned by phase of development and type of activity for each of the environmental areas.

Phase I covers the first six years of operation where first one retort is operated for three years, then a second retort is operated during the next three years. The transition phase covers the period during Phase I in which construction of the full-scale commercial facility is underway, while operation of the two retorts continues. Maximum human presence (with the attendant possibility of human disturbance) occurs during this period of time. Phase II is the full-scale commercial operation at a production rate of 55,800 BPSD.

10.2 AIR

The assessment of the impact of Rio Blanco's operations on the air quality in the area surrounding Tract C-a has been predicted by atmospheric dispersion modeling techniques. The description and results of the modeling are presented in Chapter 9 as part of the Air Quality Control Plan.

10.3 HYDROLOGY

The engineering and design of the Tract C-a mine and facilities are based on zero discharge of water. Based on this principle, the environmental effects on surface and ground water supplies will be minimal.

The most important effect on the hydrologic environment will be caused by mine dewatering. This process may eventually (after 2 years) reduce the flow of springs and seeps in the area. Mine dewatering may also reduce the amount of ground water discharge to streams in the area, eventually resulting in a reduced flow. This will probably be most severe in Yellow Creek, where flows may be reduced by as much as 50 percent after 30 years of dewatering. This same reduction of saline ground water flow into Yellow Creek may also result in reduced salinities and improved water quality in the White River. The major method of mitigating these effects will be water replacement from various other sources. Deep aquifers and alluvial water levels may be lowered by mine dewatering, but current rates of production should not be affected.

10.4 AQUATIC ECOLOGY

The number, extent and importance of aquatic habitats on or near Tract C-a are limited by the nature of the semi-arid ecosystem in which they occur. Therefore, the net impact of the proposed development on these aquatic habitats is expected to be minor.

The assessment of impacts on aquatic habitats in the study area was based on: nature of the impact, the temporal and spatial extent of the impact, and the species of aquatic organisms affected by the impact. These factors vary with each phase of development.

A. Phase I - The major impact of mining during Phase I is expected to be a reduction in flow of some springs and Yellow Creek as a result of mine dewatering and subsequent draw down of sub-surface aquifers. These reduced flows could affect periphyton and benthos communities in the spring-brooks if dry periods become excessively long. The amount of available aquatic habitat in lower Yellow Creek will also be reduced with a corresponding reduction in standing crop of periphyton and benthos.

Processed shale and overburden piles may contain potentially hazardous materials which may be leached out by normal weathering processes. This leachate could produce an undesirable impact on aquatic systems if allowed to escape into the system. This impact is not likely, however, since all disposal piles will be thoroughly compacted, then furrowed and drained into holding ponds. Both the furrows (ditches) and holding ponds will be lined to prevent escape of contaminated water. The possibility of an accidental discharge cannot be discounted, however. The impacts would range from no detectable effect to a marked decrease in aquatic species and their abundance in the affected area. The area most likely affected if this type of accident were to occur would be in Corral Gulch, Yellow Creek and the White River.

Mitigation procedures to be employed during Phase I include: water augmentation to offset flow reduction resulting from mine dewatering in certain areas, specific water quality and air quality control measures, and water supply and control methods described in Chapter 9. The effectiveness of these mitigating measures is expected to acceptably reduce the impacts on the aquatic environment during Phase I.

B. Transition Phase - The major impact of mining during the transition phase will be continued dewatering and consequent flow reductions. The organisms and areas affected are the same as those described for this impact in Phase I. The accidental contamination of aquatic habitats by runoff from processed shale will persist as a potential problem during this phase, although there will still be no direct discharge. The possible effects and mitigation procedures are similar to those discussed for Phase I.

Other impacts expected during the transition phase will be increases in siltation and turbidity resulting from increased construction and related activities. Mitigation procedures to be employed during the transition phase are of the same nature as those to be implemented during Phase I.

C. Phase II - The major impact associated with mining activities during Phase II will be the gradual elimination of any remaining aquatic habitats in a portion of Corral Gulch by the expansion of the pit. Mine dewatering activities will continue and eventually reduce the flow of all adjacent streams dependent on deep aquifers.

The contamination of aquatic habitats by processed shale runoff will continue to be a remote possibility, with widely ranging potential impacts. The control measures to be effected are expected to reduce the possibility of a discharge to an absolute minimum.

Other impacts predicted for Phase II include increased siltation and turbidity in streams as a result of continuing construction. Mitigation procedures will include those already discussed under Phase I.

The most important, while not necessarily negative, impact of ancillary development during Phase II will be the inundation of 70 m^2 of spring-brook habitat and its replacement with over a million square meters of pond habitat. This will occur in Corral Gulch as a result of the construction of a dam and water control reservoir. A less important effect includes the temporary localized increase in sediment load and siltation. Periphyton and benthos will be most severely affected by these perturbations.

10.5 TERRESTRIAL ECOLOGY

The impacts on the terrestrial ecosystem that will occur as a result of the proposed development of a prototype oil shale plant on Tract C-a will be locally severe (on a worst case basis), but when viewed from a regional perspective, development of Tract C-a by itself will have slight, if any, impact on the Piceance Basin ecosystem functioning.

Assessments of impacts on the terrestrial system are based on the effects of development activities on important species. The definition of "important species" is largely based on guidelines provided by the Nuclear Regulatory Commission in 1975. These guidelines are sometimes applied to groups of organisms rather than single species and, occasionally, the designation of important species is arbitrarily determined. Factors considered in assessing these impacts include: the nature and severity of the impact, the location of the impact, and the frequency and longevity of the impact. These factors vary during each phase of development and are, therefore, discussed by phases.

Major sources of impacts on the terrestrial ecosystem of Tract C-a include:

- The disturbance or removal of vegetation for open pit mine development, ore conveyor construction, processing sites, processed shale, and overburden disposal areas, and ancillary facilities
- Water and wind-borne effluents from the processing plant and cooling tower
- An increase in noise levels resulting from mining and processing
- An increase in dust levels due to mining, construction, processing, and increased vehicular traffic
- A drop in the local water table due to mine dewatering

Vegetation loss is one of the major impacts expected to occur during development. Several sources of vegetation disturbance have been identified, including open pit mine excavation, ore conveyor, plant, processing and support facility construction, and road building. By 2015 a cumulative total of 2,340 ha (5,755 A) of vegetation will have been disturbed; however, 1740 ha (4,310 A) will have been rehabilitated by that time. The effects of area disturbance will include loss of vegetation and, therefore, a loss of wildlife habitat and a concomitant loss of wildlife numbers in the area. This loss of vegetation will be predominantly pinyon-juniper and sagebrush, followed by lesser amounts of mixed brush and other vegetation types. Some animals (small mammals, non-mobile invertebrates) will be destroyed outright during area disturbance; others (birds, deer and horses) will be forced to flee the disturbed area. This displacement will result in increased competition for the remaining range. Once the vegetation cover is removed, erosion and runoff will increase, contributing to fugitive dust load and siltation of streams.

Mitigation procedures which can reduce impacts of vegetation removal include:

- Limiting areal disturbance as much as possible
- Revegetation of disturbed lands as soon as feasible
- Enhancement of adjacent habitats to offset losses due to development
- Stringent adherence to erosion control measures

Gaseous and particulate emissions from the processing facilities could cause tissue damage in plants and pulmonary tissue and physiological changes in animals. SO_2 appears to be the most hazardous to vegetation. Cooling tower salt water drift can also cause plant tissue damage and affect plant community structure. Gaseous and particulate emissions and salt drift will be controlled by use of emission control equipment.

Other, less important, impacts of oil shale development include increased noise and dust levels and spills of chemicals or waste products. Mining activities, conveyors, ore trucks, crushers, etc. can produce excessive noise which will probably cause mobile animals to initially flee the impact area; however, many will habituate to the noise and return to the impact area except for areas immediately adjacent to the noise source. Noise suppressors (e.g., mufflers on haul trucks) will be used as a means of mitigation whenever possible. Mining and trucking operations will produce fugitive dust which can lower productivity of plants and create a pulmonary hazard for animals. Dust-suppression measures will be implemented to mitigate these impacts.

Local oil shale related impacts will be (at the worst) severe due to physical destruction of habitat (food, water, and shelter), increased human presence, mine dewatering, and emission blowdown; however, mitigative action will greatly minimize or reduce these effects.

CHAPTER 11
MONITORING

11.1 INTRODUCTION

Once the development of the prototype oil shale facility on Tract C-a commences, the project could continue for many years. Lease stipulations require the initiation of a monitoring program on the leased land ". . . six months prior to the commencement of the development operations." The monitoring program should continue until the ". . . Mining Supervisor has determined to his satisfaction that environmental conditions have been established after the termination of development operations which are consistent with the requirements of applicable Federal and state statutes and regulations . . ."

In response to these lease stipulations, monitoring programs have been developed on the basis of data taken during the first year of baseline data collection. These monitoring programs are designed to collect data which will reveal discrete changes in the environment which result from developmental activities. The monitoring programs discussed herein will be reviewed and possibly revised at the conclusion of the second year of baseline data collection effort if additional information indicates that this is desirable.

Monitoring programs are described for air quality, meteorology, terrestrial ecology, aquatic ecology, hydrology and revegetation studies. The air quality program is designed to provide a record of changes in air quality from baseline conditions. The meteorological monitoring program is designed to aid in identifying the impacts of plant operations. The terrestrial ecology monitoring program is designed to monitor the: effects of habitat disturbance and associated human activity on terrestrial ecosystems; areas dominated by unusually sensitive plant species; and success of habitat enhancement programs. The aquatic ecology monitoring program will be used to provide insight into the effectiveness of the RBOSP water quality control plan. The hydrology monitoring program will provide similar information about surface and sub-surface water and provide additional information on draw down of aquifers. The revegetation monitoring program is designed to determine the success of the revegetation program in establishing a self-sustaining vegetation community.

11.2 AIR QUALITY

The air quality monitoring program will be conducted to provide a record of changes in air quality from baseline conditions; a continuing check on compliance with provisions of the lease and all applicable Federal, state and local environmental protection and pollution control requirements; and timely notice of detrimental effects and conditions requiring correction.

Both ambient air quality and selected emission sources will be monitored for concentrations of the various parameters such as sulfur dioxide (SO_2), hydrogen sulfide (H_2S), particulates, total hydrocarbons (THC), methane (CH_4), ozone (O_3), and nitrogen oxides (NO and NO_x).

Ambient air quality monitoring stations will be used to obtain data for determination of the following:

- Background ambient concentrations of air quality parameters unaffected by development operations.
- Maximum ambient concentrations of air quality parameters after the effects of Tract C-a operations.
- Performance of air pollution control devices.
- Ambient air quality in the neighborhood of biological test sites.

Monitoring stations will be located in the area of maximum ground level concentrations of parameters as predicted by modeling to demonstrate compliance with ambient air quality regulations. Background concentrations are determined in order to accurately establish the impact of Tract C-a operations at the point of maximum concentration and at the biological monitoring sites. Other stations will monitor emissions from mining and processed shale disposal operations.

Air Quality parameters will be measured at five sites which are shown on Figure 2-11-1. Table 2-11-1 lists the parameters measured at each site and the rationale for their location.

11.3 METEROLOGY

The meteorological monitoring program is designed to aid in identifying the impacts of plant operations; evaluating the results of mitigative procedures; and demonstrating that the Tract C-a operations are complying with all Federal, state, and local requirements.

The meteorological parameters to be monitored are detailed in Table 2-11-2. This compliment of parameters will provide:

- Data to estimate the origin of pollutants and to provide associated meteorological conditions in the event that abnormal concentrations are measured;
- Data to identify plant site specific formation and persistence of adverse meteorological conditions (inversions);
- Data for fine tuning the dispersion models to existing conditions through correlations among measured meteorological conditions and air quality concentrations.

The meteorological monitoring program will measure meteorological parameters at three sites. Sites 1 and 2 are shown in Figure 2-11-2. Site 8 will be a combination air quality/meteorological site located in the neighborhood of the biological test sites. The exact location has not yet been determined. The background air from the predominant wind direction will be measured at the 10-m level of Site 2. Sites 1 and 2 are existing sites, used during the baseline data gathering program. At valley sites 3 and 4, winds are governed almost entirely by channeling effects and drainage flows. This behavior will be well documented during the baseline data program. Meteorological data from these sites probably could not identify origins of measured pollutants; therefore Sites 3 and 4 will not be used as meteorological sites during the monitoring program.

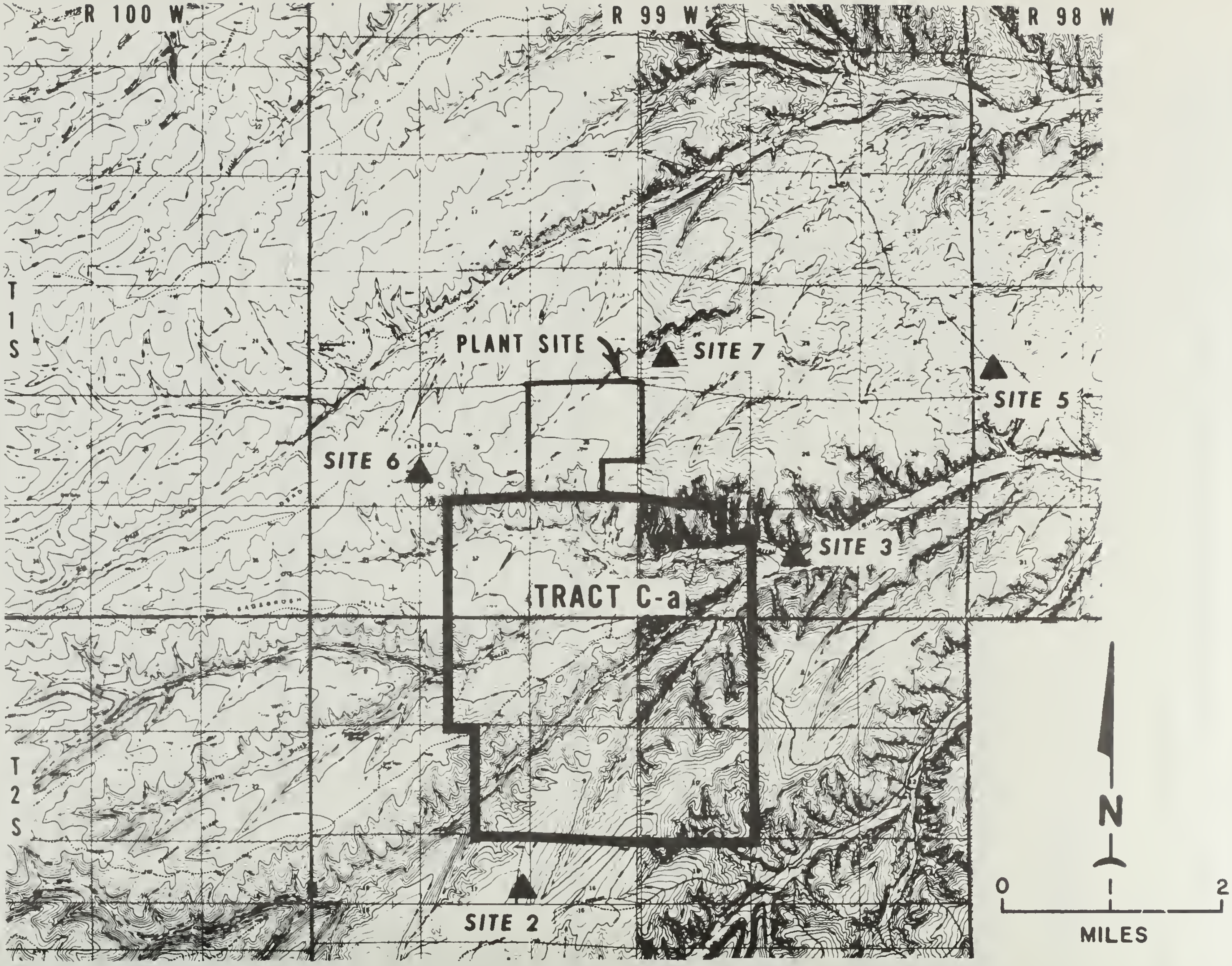


Figure 2-11-1

PROPOSED AMBIENT AIR MONITORING STATIONS

Table 2-11-1

PROPOSED AIR QUALITY PARAMETERS TO BE MONITORED

Site	Distance from Plant	Parameters	Justification
2	4 mi S	SO_2, H_2S, O_3, NO, NO_x, THC, CH4, and particulates	Provide background levels of pollutants in ambient air approaching site from predominate wind direction.
3	2-1/2 mi SE	Particulates	Monitor dust concentrations from the mine and processed shale and overburden disposal areas.
5	4 mi E	Particulates	Monitor dust concentrations down wind from processed shale and overburden disposal site along nearest public access road.
6	2 mi WSW	SO_2, H_2S, O_3, NO, NO_x, THC, CH_4, and particulates	Provide measurement of regulated air quality parameters at the point of predicted maximum concentration for NMHC and SO_2.
7	1/2 mi W	Particulates	Provide measurement of ambient air particulates at point of predicted maximum concentration.
8	Undetermined	SO_2, H_2S, O_3, NO, NOx, THC CH_4 and particulates	Correlation of ambient air quality parameters with biological monitoring programs.

Table 2-11-2

PROPOSED METEOROLOGICAL PARAMETERS TO BE MONITORED

Parameter	Site 1		Site 2	Site 8
	10-Meter Level	60-Meter Level	10-Meter Level	10-Meter Level
Solar Insolation	Yes(1)	No	No	No
Wind Speed	Yes	Yes	Yes	Yes
Wind Direction	Yes	Yes	Yes	Yes
Air Temperature	Yes	Yes	Yes	Yes
Temperature Difference (60-meter level - 10-meter level)	Yes	Yes	No	No
Relative Humidity	Yes	No	No	No
Wind Sigma	Yes	No	No	No
Precipitation	Yes(1)	No	Yes(1)	Yes(1)
Evaporation	Yes(1)	No	No	Yes
Snow Course	Yes(1)	No	No	No

(1) Measured below the 10-meter level.

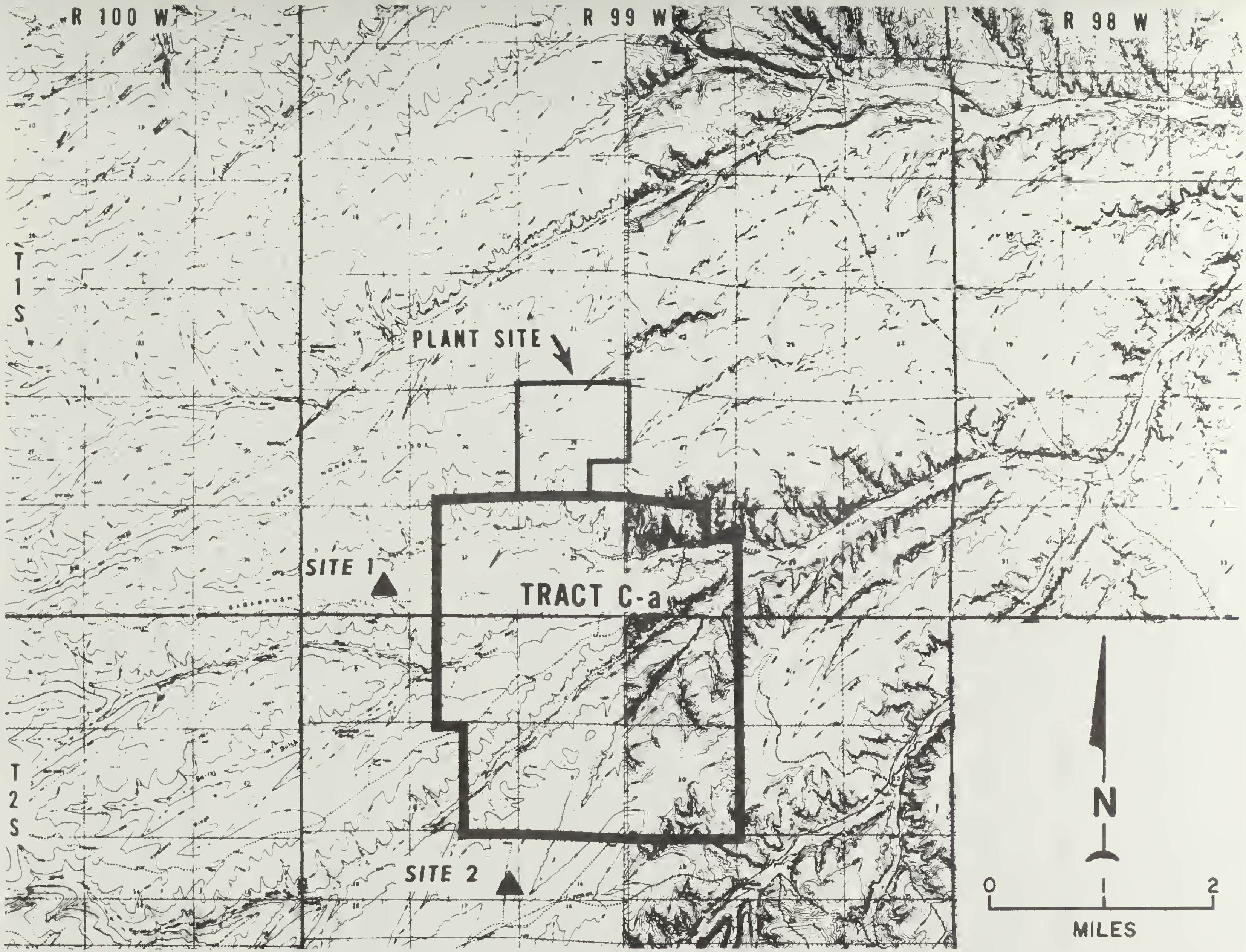


Figure 2-11-2

PROPOSED METEOROLOGICAL MONITORING STATIONS

Meteorological conditions representative of those affecting the dispersion of pollutants from the processing plant will be measured at the 10-meter and 60-meter levels at Site 1. This information can be correlated with upper air conditions based on data collected during the two-year baseline program.

11.4 TERRESTRIAL ECOLOGY

Baseline data have been collected on the terrestrial ecosystem of the study area for vegetation, range condition, mammals, birds, amphibians, reptiles, and invertebrates. These data have been assimilated to develop a monitoring program which will provide information on changes in the ecosystem which occur as a result of oil shale development.

Eight primary monitoring sites will be placed in areas where processing emissions and area disturbance are expected to occur as determined from dispersion modeling. Each of these sites will be placed in areas with different predicted emission levels. Therefore, they will represent "pollution gradient" areas. In addition, monitoring sites will be placed next to areas of land disturbance to monitor species dispersal, dust, noise, and other impacts related to development. Other monitoring sites established within habitat enhancement areas will demonstrate the effectiveness of the enhancement program.

Control sites will be placed in areas that will not be affected by oil shale development. These sites will be used for comparison with primary monitoring sites to determine the difference between natural changes and changes which result from oil shale development. In addition, these sites will be used as the basis to judge the effectiveness of the enhancement program.

Close scrutiny of the control sites is absolutely essential since the only sure way to demonstrate environmental perturbation by development is to determine that any changes which occur in a system are outside or beyond natural changes which would have occurred without the development. Therefore, elaborate and well-designed programs founded upon statistical verification are proposed.

The overall statistical design of the monitoring program will be divided into two phases. During the first (pre-operational) phase, the monitoring system will be fine tuned. Data collected at all monitoring sites will be compared by parameters both within sites, and between sites, to determine if a statistical difference between them exists, and to demonstrate the degree of any such difference. This information will be used to describe the baseline conditions with appropriate qualifications concerning natural fluctuations. The second phase (operational) of the statistical design will be developed during oil shale operations. During this phase, data will be statistically compared for parameters within each monitoring site, between all classes of monitoring sites, and with the previously described natural baseline conditions. Statistical tests will also be applied to yearly data to determine whether statistical differences occur between sites, controls, and years.

Parameters to be monitored during this program include:

- phytosociological investigations
- range condition and trend surveys
- primary producer biomass dynamics studies
- remote sensing
- invertebrate consumer dynamics investigations
- plant-disease relationship investigations
- vertebrate population dynamics studies
- trace metal analyses of selected plants and animals

A holistic approach will be utilized in ultimately determining the effects of oil shale development on the ecosystems of the area. Multivariate analysis will be applied to a variety of applicable parameters in order to establish correlations and cause and effect relationships.

Thus, through this analysis process, plant biomass can be compared to animal population levels, plant vigor can be related to insect presence, bird populations can be related to insect levels, and dust and noise levels can be related to animal occurrence and so on. This information can be used to determine the overall effectiveness of habitat enhancement procedures (e.g., correlation between available plant biomass and animal numbers).

A. Flora - A permanent phytosociological transect will be established in each of the three enhancement areas to determine structural and compositional vegetation changes that result from habitat enhancement procedures. Investigations will be conducted each year at the height of the growing season, approximately mid-June to mid-July. A modification of the line-strip technique will be used during the phytosociological investigations.

For tree and shrub strata a line transect will be used to determine the foliage intercept distance along the line for each of the transects. In addition to recording foliage intercept, a count will be made of shrubs, seedlings, and saplings of each species. Density values for shrubs and for seedlings and saplings of tree species will be determined from this census. Census data will be collected and recorded for a series of five quadrats. This series of quadrats will serve as the basis for frequency values for the shrub and tree strata.

For mature trees located in each quadrat, the diameters will be recorded. The enumeration of these recorded entries will serve in determination of density in the mature tree class. Trunk diameters will be recorded for trees over 7.6 cm (3 in). The trunk diameters will be converted later to basal area values. Size-class distribution will also be derived from the recorded measurements of trunk diameters.

For all flowering plants a phenology code will be recorded to indicate the stage of development for each species observed in a given sampling period: (1) emergent, (2) vegetative, (3) initiation of flowering, (4) flowers fully developed, (5) initiation of fruits, (6) fruits fully developed, (7) dehiscence or dispersal of seeds, and (8) death or dormancy of plant and other factors where deemed applicable.

Herbaceous cover values will be estimated. Each species will be identified and noted. Plants not identifiable to the species level will be collected at a nearby location and assigned a code number corresponding to the entry on the data sheet. The ground cover of each species will be estimated. Frequency values will be derived from the recorded occurrence of each species in the ten transects. Density, or the number of individuals of species occurring in each quadrat, will also be recorded. Density of grasses or grass-like species will not be recorded.

B. Fauna - Invertebrate sampling will be conducted at each of the habitat enhancement and control sites to determine the changes that occur in invertebrate population dynamics as a result of habitat enhancement procedures. Sampling methods will emphasize those invertebrate groups expected to be sensitive to oil shale-induced perturbations. These groups include litter and flying invertebrate fauna and western harvester ants. The latter group has been documented as a colonizer of disturbed habitats in studies of the insect fauna of overgrazed areas.

The litter decomposition and litter fauna will be monitored using litter bags. Every four months a litter bag will be removed from each of the stations and analyzed. The weights will be recorded and decomposition rates calculated. If there is a significant shift in the decomposition rates, then an investigation will be conducted to determine cause. The invertebrates obtained from the extraction will be classified and enumerated. This information will be used for sudden shifts in represented taxa and species diversity; any large change in these categories will be investigated.

Population studies of actively flying invertebrates will be conducted using Malaise traps. One trap will be placed at each of the sampling sites to capture mobile airborne species. A wire fence will be put up around each trap to prevent interference from ungulates. The Malaise traps will be opened on the first day of sampling and checked and insects removed daily for 10 days. Samples will be labeled and logged into the record book and transported to the laboratory for identification and enumeration.

Western harvester ant colony density and relative colony vigor rating will be evaluated at each of the designated sampling sites. Colony density will be estimated by random sampling. An average number of western harvester ant colonies per hectare will be calculated. Colony vigor tests will be performed in five randomly selected colonies at each site. Vigor tests will be conducted on the same colonies each sampling period.

The vertebrate monitoring program is designed to assess changes in vertebrate population structure and dynamics that result from wildlife management procedures. The effectiveness of habitat enhancement procedures for management species, as well as the secondary effects of habitat enhancement on other components of the ecosystem, will be determined.

For small mammals a live trapping program will be conducted at each of the habitat enhancement and control sites. To coincide with periods of high small mammal activity and to provide reliable data on population size, survivability, immigration, recruitment, productivity, and other population parameters, sampling will be conducted during May, July, and September. Sampling will follow the parallel line technique.

Traps will be reset and rebaited as necessary. All animals captured will be distinctively marked by unique toe-clipping combinations and released. For each animal captured, the species, sex, age class, weight, reproductive status, general physical condition, capture location, and animal identification number will be recorded on a standard trapping form.

To assess the effectiveness of lagomorph habitat enhancement procedures a road transect will be established traversing major habitat types including the enhancement areas. These road transect surveys will be in conjunction with the owl transect program.

Species population size, and other population parameters will be determined by the Emlen strip transect method for songbirds (and certain non-songbirds) at each of the sites during May, July, and September. All transects will begin at a specified small mammal live-trapping station and will be permanently marked.

Winter road census ground counts will be employed to assess the effectiveness of sage grouse management procedures. All sage grouse encountered will be counted, their location plotted on field maps, and sex and ages tallied on field data sheets.

Census will be used to monitor changes in raptor species composition and relative abundance that might result from the habitat disturbance and increased human activity associated with oil shale development. To determine the success of raptor mitigative efforts, the route will include each of the habitat enhancement areas. Raptor surveys will be conducted during both winter and summer because of seasonal changes in raptor species composition. All raptors observed will be recorded as to species, location, sex, and age if possible.

To survey owls, road transects will be driven during February and July. These surveys will commence within two hours after sunset. At each stop, the observer will record on a field data sheet, by species, the number of owls heard or observed during an observation period.

Aerial surveys will be conducted to determine relative changes in mule deer distribution and abundance that might result from the habitat disturbance and increased human activity associated with oil shale development near Tract C-a. These surveys will employ a high-wing aircraft designed to permit slow flight at low levels above the ground. The plane will be flown along standardized transects. Survey flights will be conducted at approximately monthly intervals from late October through early April to assess the mule deer populations and migrations during the winter period.

Pellet group counts will be used to monitor the effectiveness of habitat enhancement procedures. The technique involves counting the number of pellet groups deposited during a known time period on an area of known size. This information, coupled with a knowledge of big game defecation rates, can be used to compute the levels of deer use in an area.

Randomly selected pellet group transects will be established within each of the six habitat enhancement types within six months after habitat modification is completed. Plots will be inspected annually during the spring and data compared to pellet plot transects established in relatively undisturbed areas to establish relative mule deer habitat use patterns.

In addition to the number of pellet groups counted, a short written description of vegetation and landforms will be recorded for each plot during transect establishment. All old pellets will be cleared from the plots during the establishment phase. Plots will be inspected annually during the spring and pellet groups deposited during the census period will be counted, removed, and recorded on field data sheets.

RBOSP is presently reviewing a plotless method for determining mule deer abundance and distribution. If this technique is applicable to the Tract C-a environs, then RBOSP will contemplate substituting this method into the second year of baseline program.

11.5 AQUATIC ECOLOGY

The aquatic communities or assemblages included in the RBOSP aquatic baseline studies included the benthos, periphyton, phytoplankton, zooplankton, aquatic macrophytes and fish. During the initial year of aquatic baseline studies, trends in the baseline data suggest that certain of these communities may provide a more definitive assessment of the natural and man-related trends in the aquatic ecosystems during the monitoring phase of the Rio Blanco Oil Shale Project. Use of these biological parameters in monitoring will also provide insight into the effectiveness of the RBOSP water quality control plan. In addition, certain physical and chemical parameters which, from the initial year of baseline data appear to influence the biotic community composition and abundance, will be an integral part of an aquatic monitoring program.

Based upon the initial year of baseline data, it appears that the major source of autochthonous primary production in aquatic habitats of the area is the periphyton, while the phytoplankton generally constitute a secondary source of such production. The secondary consumer level in aquatic habitats on or near Tract C-a is generally occupied by benthic invertebrates and, to a lesser extent, by planktonic invertebrates (zooplankton). Also, fish (which generally confine their range to the White River) act as either secondary or tertiary consumers.

Because of their dominant role in the aquatic ecosystems of Tract C-a and vicinity, and because of their limited mobility and thus their susceptibility to physical and chemical changes, the benthos and periphyton communities will be included in the monitoring programs. The abundance, species composition and diversity of these organisms will be evaluated to assess trends due to natural and man-induced variations. In addition, studies of fish species composition, abundance, age and growth, and condition factors will be included in future monitoring. The comparison of condition factors between the baseline period and some future period is particularly useful in assessing environmental perturbations. Physical and chemical parameters will be utilized in monitoring of aquatic ecosystems. Evaluation of data from the second year of baseline studies will provide further rationale for addition or deletion of physical and chemical parameters as well as biological parameters.

Physical characteristics of the streams at each sampling site will be measured and related to baseline chemical and biological conditions. The physical measurement program will also include those chemical parameters measured in conjunction with field sampling operations. Stream velocity will be measured. The stream substrate will be visually classified at each station at the same time as benthic samples are collected. Color and odor will be determined for each sample and the turbidity of each sample will be determined. Field measurements of dissolved oxygen will be taken with a portable dissolved oxygen meter. Other parameters which will be determined in the field include pH, specific conductance, water temperature, depth, width, and alkalinity.

Certain chemical characteristics which have been determined to be of particular biological significance to the streams will be monitored and related to the physical and biological data collected during baseline studies. Chemical determinations will likely include: ammonia nitrogen, dissolved calcium, dissolved chloride, total hardness, dissolved magnesium, Kjeldahl nitrogen, dissolved nitrate, dissolved nitrite, dissolved orthophosphate, total phosphate, dissolved potassium, dissolved silica, dissolved sodium, dissolved sulfate, dissolved organic carbon, total organic carbon, suspended solids, and total dissolved solids. The analytical methods, limits of detection and methods of sample preservation for the aforementioned analyses will be the same as those utilized during baseline studies.

Certain characteristics of stream sediments will be monitored to provide a measure of current conditions for comparison with conditions which prevailed before tract development was initiated. Chemical determinations will include the following parameters: aluminum, arsenic, lead, mercury, Kjeldahl nitrogen, total phosphate, volatile solids and zinc. Analytical methods will be the same as those utilized during aquatic baseline studies.

Periphyton studies will be conducted to determine the effect of development on species composition, standing crops and diversities of periphyton communities. Samples will be collected at each station from natural substrates and will be used to estimate abundance and determine biomass.

The benthos (macroinvertebrates) monitoring program will be to describe the benthic community at each sampling station. This will include taxonomic composition, abundance of these described taxa, and species diversity indices. Samples will be collected and laboratory methods will be those utilized during aquatic baseline studies.

The fish studies will be to monitor trends in community composition and determine certain aspects of growth, spawning and condition as development proceeds. Fish collections will be limited to the White River. They will be made by electrofishing methods similar to those used in baseline studies. Stream sections of appropriate length will be sampled. The probes will be moved upstream where possible, and sometimes downstream. Captured fish will be held in holding nets or buckets of water until one or more stations has been sampled. The larger fish will then be weighed and measured. Stomachs will be excised from some of the larger fish for laboratory analyses, while smaller fish will be preserved whole. Laboratory methods will be similar to those used during baseline studies. Length-frequency analyses will be done on flannelmouth suckers, mottled sculpin, and speckled dace by the same method used during baseline studies.

Based on data obtained during the initial year of aquatic baseline studies and upon the assessment of potential effects of the Rio Blanco Oil Shale Project on existing aquatic habitats, sixteen sampling sites have been selected for monitoring short-term and long-term trends.

These stations represent all major aquatic habitat types and aquatic biota encountered in the area and include areas most susceptible to disturbance as well as downstream areas which would serve in monitoring the effectiveness of the water control plan. During the monitoring phase of the study, deletions and/or additions to selected sampling locations can be expected. The list of sites also includes three USGS gaging stations.

The frequencey of aquatic sampling during the monitoring program will be designed to determine natural and human-related variations in the aquatic communities being monitored. An evaluation of natural variations observed during the baseline studies will determine the sampling frequency required to follow the natural variability in aquatic communities. An evaluation of the initial year of baseline data suggests that the sampling frequency required to record trends in aquatic ecosystems on and near Tract C-a is three to four times during the period from April to November. After collection and evaluation of additional baseline data, the sampling frequency to be utilized during the monitoring phase can be more precisely defined.

11.6 HYDROLOGY

There are currently eleven surface gaging and six precipitation stations in operation, but the number of constituents analyzed on a monthly basis will be reduced during the operational phase; however, a complete analysis for the baseline constituents will be completed twice a year. Should any of the values exceed those recorded during the baseline period, a complete analysis of parameters will be conducted to determine if pollution from the activities is responsible for the variation. If this is the case, the source will be located and appropriate preventative action will be taken.

Fifteen alluvial aquifer holes were studied during the baseline period. These and four additional holes will be used as monitoring sites. Analysis of baseline parameters will be completed twice a year. Parameters analyzed on a monthly basis will parallel those measured at the surface gaging station. These include: ammonia, bicarbonate, fluoride, lead, sodium, zinc, pH, and boron. These parameters are expected to be more concentrated in the water supply than in the stream flows and alluvial aquifers.

During baseline studies, 31 deep aquifer holes were studied. During monitoring, 11 of these will be used to monitor water levels in the study area. The gradient of the two deep aquifers will be toward the mine as a result of dewatering; therefore water quality data from these holes will not be collected. However, the water pumped out of the mine during the dewatering will be analyzed frequently.

The monitoring of the piezometric head changes due to the dewatering of the mine will be measured in fourteen observation holes located in the basin outside of the Tract C-a area.

11.7 REVEGETATION

The revegetation program for RBOSP is currently in the experimental stages. Test plots have been set up to select best adapted seed species, to determine the effectiveness of various mulches, to determine the best method and types of fertilization, and to determine effects of slope aspect on revegetation. Revegetation of disturbed lands will be accomplished as soon as feasible. The purpose of the monitoring program is to determine if the criteria for revegetation success are being met.

Areas to be monitored will include road cuts, construction sites, corridors, and disposal piles. The three former areas will be monitored by qualitative methods. Intensive quantitative sampling will be done in the latter area (disposal piles).

If plant establishment is succcessful after three years, the monitoring program will be converted to a remote sensing program which will begin in the 5th year and continue at 5-year intervals. A soils program will be conducted concurrently with the revegetation studies.

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